



Western Prairie Fringed Orchid Monitoring Protocol for Pipestone National Monument

Natural Resource Report NPS/HTLN/NRR—2007/013



ON THE COVER

Western prairie fringed orchid (*Platanthera praeclara*) at Pipestone National Monument.

Western Prairie Fringed Orchid Monitoring Protocol for Pipestone National Monument

Natural Resource Report NPS/HTLN/NRTR—2007/013

Craig C. Young, Gary D. Willson, Michael D. DeBacker, Lloyd W. Morrison, Holly J. Etheridge, and Jennifer L. Haack
National Park Service
Heartland I&M Network
Wilson's Creek National Battlefield
6424 West Farm Road 182
Republic, MO 65738



July 2007

U.S. Department of the Interior
National Park Service
Natural Resource Program Center
Fort Collins, Colorado

The Natural Resource Publication series addresses natural resource topics that are of interest and applicability to a broad readership in the National Park Service and to others in the management of natural resources, including the scientific community, the public, and the NPS conservation and environmental constituencies. Manuscripts are peer-reviewed to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and is designed and published in a professional manner.

Natural Resource Reports are the designated medium for disseminating high priority, current natural resource management information with managerial application. The series targets a general, diverse audience, and may contain NPS policy considerations or address sensitive issues of management applicability. Examples of the diverse array of reports published in this series include vital signs monitoring plans; monitoring protocols; "how to" resource management papers; proceedings of resource management workshops or conferences; annual reports of resource programs or divisions of the Natural Resource Program Center; resource action plans; fact sheets; and regularly-published newsletters.

Views, statements, findings, conclusions, recommendations and data in this report are solely those of the author(s) and do not necessarily reflect views and policies of the U.S. Department of the Interior, NPS. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

Printed copies of reports in these series may be produced in a limited quantity and they are only available as long as the supply lasts. This report is also available from the Heartland I&M Network website (<http://www.nature.nps.gov/im/units/HTLN>) on the internet, or by sending a request to the address on the back cover.

Please cite this publication as:

Young, C. C., G. D. Willson, M. D. DeBacker, L. W. Morrison, H. J. Etheridge, and J. L. Haack. 2007. Western Prairie Fringed Orchid Monitoring Protocol for Pipestone National Monument. Natural Resource Report NPS/HTLN/NRR—2007/013. National Park Service, Fort Collins, Colorado.

NPS D-43, July 2007

Executive Summary

The western prairie fringed orchid monitoring protocol guides monitoring of this threatened plant on Pipestone National Monument. The monitoring protocol is designed to achieve two objectives:

1. Track temporal and spatial changes in the abundance and vigor (height, flowering, and fruit production) of flowering orchids at Pipestone National Monument in relation to fire, soil moisture, and precipitation.
2. Track changes in orchid habitat structure in relation to fire and precipitation

To achieve these objectives, monitoring involves four components: 1) counts and mapping of flowering orchids, 2) measurement of plant structure in the orchid habitat, 3) year-round soil moisture monitoring at a fixed point, and 4) counts and characterization of capsules. The Heartland Inventory and Monitoring Network, in cooperation with Pipestone National Monument, will conduct monitoring annually. The network will carefully analyze and archive collected data. The network will also prepare an annual report detailing the status of the western prairie fringed orchid for park staff at Pipestone National Monument.

Acknowledgements

The National Park Service's Inventory and Monitoring Program provided funding for western prairie fringed orchid monitoring protocol development and continues to fund monitoring at Pipestone National Monument. The original edition of the protocol "Western Prairie Fringed Orchid Monitoring for Pipestone National Monument" was written in 2000 by Dr. Gary D. Willson, then of the U.S. Geological Survey, Northern Prairie Wildlife Research Center, Missouri Field Station. Peer review of the original protocol was conducted by the Northern Prairie Wildlife Research Center and benefited from the comments of James Stubbendieck, Wes Newton, Qinfeng Guo, and DeeAnna Adkins. We have updated the protocol to conform to NPS standards for NPS Inventory and Monitoring Program protocols (Oakley et al. 2003) and to include a few modifications and additions. This protocol uses sections of text without citation from the original protocol. Numerous NPS staff and staff from other agencies, particularly the USGS, have contributed to the development of this protocol. The list of authors simply reflects those who put down on paper the work of this larger group over the past 13+ years.

Contents

1. Background and Objectives	1
2. Sampling Design	5
3. Field Methods	5
4. Data handling, analysis, and reporting.....	6
5. Personnel Requirements and Training.....	3
6. Operational Requirements	3
7. References.....	5
Standard Operation Procedure 1: Field Work Preparation	8
Standard Operation Procedure 2: Training	12
Standard Operation Procedure 3: Using the Trimble GeoXT (TerraSync version 2.5).....	14
Standard Operation Procedure 4: Western Prairie Fringed Orchid Census.....	36
Standard Operation Procedure 5: Vegetation Profile.....	40
Standard Operation Procedure 6: Soil Moisture	44
Standard Operation Procedure 7: Western Prairie Fringed Orchid Capsule Monitoring	45
Standard Operation Procedure 8: Precipitation Data	47
Standard Operation Procedure 9: Data Management.....	49
Standard Operation Procedure 10: Data Summary and Analysis	53
Standard Operation Procedure 11: Reporting	57
Standard Operation Procedure 12: Revising the Protocol	60

This page intentionally left blank.

Western Prairie Fringed Orchid Monitoring Protocol for Pipestone National Monument

1. Background and Objectives

1a. Western prairie fringed orchid biology

The western prairie fringed orchid (*Platantera praeclara* Sheviak & Bowles) is a smooth, erect, perennial herb. Plants develop from either a germinated seed or a fleshy tuber. Individual plants regenerate vegetatively during the growing season by forming a new tuber and perennating bud that develop a root system and shoot for the following growing season (Dressler 1981).

Vegetative shoots emerge from the soil from mid-April in the southern range to late May in the northern range (Pleasants 1995). Flowering usually occurs about two months after emergence. Some individuals remain vegetative throughout the growing season (Sather and Smith 1994; Sieg and King 1995). These plants usually have only one to three basal leaves (Sieg and King 1995) (Figure 1).

Seed germination and development of perennating buds require a symbiotic association with mycorrhizal fungi (Bowles 1983, USFWS 1996, Sharma 2003). Consequently, the regeneration niche includes conditions suitable for the seed as well as the mycobiont (Bowles 1983). Successful germination leads to the development of an achlorophyllous protocorm. Soil moisture likely controls the number of vegetative plants that emerge from the perennating buds and seeds, as well as the fraction of plants that produce stems and flowers in a given year (Bray and Wilson 1992, Sieg and King 1995). Drought-induced dormancy and below-ground mycotrophy may provide a mechanism to avoid and survive unfavorable conditions.

Each flowering plant usually has a single, unbranched stem bearing two to five smooth leaves that are 7 to 15 cm long. The inflorescence is a showy spike with 5 to 25 creamy white flowers (Figure 2). Mature flowering plants usually overtop the grass canopy and are visible at distances of a few to 20 meters. The inflorescence is determinate with a few flowers opening from the bottom each day; individual flowers last about 10 days, and large plants may flower over a three-week period (Bowles 1983). Prairie hawkmoths (Sphingidae) play an important role in western prairie fringed orchid pollination (Bowles 1983, Sheviak and Bowles 1986, USFWS 1996), which is required for seed production (Sheviak and Bowles 1986). The long nectariferous spur orients the moth towards the pollinaria. The position of the pollinaria and the viscidia shape promote attachment to the eyes of moth pollinators (Sheviak and Bowles 1986). Fruit set follows successful flowering and pollination. Capsules dehisce in autumn, releasing thousands of seeds, which are primarily wind-dispersed. Populations may propagate vegetatively for several years, but seed establishment is required for recruitment of new individuals (Bowles 1983).

Flowering in the western prairie fringed orchid may be suppressed by litter accumulation and stimulated by fire (Bowles 1983; Bowles and Duxbury 1986). The effects of fire on the orchid are likely multi-faceted with fire playing an important role in: 1) stimulating flowering, 2) stimulating growth, 3) providing regeneration sites, and 4) extending longevity (Pleasants 1995).

Fire may also stimulate growth of symbiotic mycorrhizae. Fire after emergence damages leaf tissue, however, which diminishes immediate photosynthetic capabilities and eventually reduces below-ground energy storage (Bowles 1983, Pleasants 1995). Fire management must take into account plant phenology and soil moisture. Early burns may stimulate early emergence, but increase the risk of frost damage (Bowles 1983). Late burns may damage leaves, flowers, or fruits. Several papers have suggested that although fire may reduce competition for light thereby stimulating growth and reproduction (USDA 1999) and providing regeneration sites, the removal of litter may also increase moisture loss (Bowles 1983, Knapp and Seastedt 1986, Pleasants 1995, Sieg and King 1995, Willson et al. in prep.). Precipitation before or after fire could mitigate moisture loss, while drought would exacerbate the effects of moisture stress.

The western prairie fringed orchid is reportedly long-lived (Sheviak and Bowles 1986). Recent data from demographic studies, however, suggest plant presence and longevity varies geographically depending on soil moisture and other factors (Sieg and Bjugstad 1994; Sather and Smith 1994; Pleasants 1995; Sieg and King 1995, Wolken, Sieg, and Williams 2001). During a four-year study at Sheyenne National Grassland in North Dakota, Sieg and King (1995) determined that an individual flowering plant can assume one of three distinct life-stages the following year. The individual may: 1) flower again the following year, 2) reappear but remain in the vegetative stage, or 3) may be absent altogether (i.e., dormant or dead). In addition, dormant plants can reappear in subsequent years as either vegetative or flowering plants; the plant is unlikely to emerge after three years of dormancy (Sieg and King 1995). In a complementary study, Sieg and Wolken (1999) found no evidence of viable root systems for ten flowering orchids in standing water that died during the growing season. Out of 23 partially submerged orchids that survived the 1993 growing season, four emerged in 1994, one emerged in 1995, and no emergence was detected in 1996.



Figure 1. Vegetative western prairie fringed orchid. Photo by Dr. Jyotsna Sharma.



Figure 2. Flowering western prairie fringed orchid.

1b. Rationale for selecting this resource to monitor

The western prairie fringed orchid was once found throughout much of the tallgrass prairie in the central United States and southern Canada (Bowles and Duxbury 1986). Conversion of native prairie to agricultural land destroyed most of the species' habitat. Remaining populations are threatened by fragmentation of residual habitat, contact with herbicides used to control weeds, loss of pollinators due to application of insecticides, growing season fire and grazing, hydrological changes caused by drought and human activity, and competition from exotic plant species (USFWS 1996).

Concern about the limited number of populations and the significant number of threats led to the federal listing of the species as threatened (USFWS 1989). Approximately 90% of all extant plants occur in Manitoba, Canada, Minnesota, and North Dakota (USFWS 1996, Sheviak and Bowles 1986). Population size in these locales ranges from tens to thousands of plants, although most remaining populations consist of fewer than 50 individuals (USFWS 1994). Plants are found most often in mesic tallgrass prairies and meadows in association with native prairie plants such as big bluestem (*Andropogon gerardii* Vitman.), little bluestem (*Schizachyrium scoparium* (Michx.) Nash), sedges (*Carex* spp.), switchgrass (*Panicum virgatum* L.), and prairie sandreed (*Calamovilfa longifolia* (Hook.) Scribn.) (Sheviak and Bowles 1986).

The population at Pipestone National Monument (PIPE) plays an important role in the recovery of the species. Delisting of the western prairie fringed orchid requires "sites that include

occupied habitat harboring 90 percent of plants in each ecoregion are protected at protection levels 4 through 9 (public ownership or higher level of protection)” (USFWS 1996). Within the North Central Glaciated Plains section of the Prairie Parkland Province, 535 orchids were known from eleven sites—nine in Iowa and two in Minnesota (USFWS 1996). Protecting the populations at Pipestone National Monument, Blue Mounds State Park in Luverne, Minnesota, and Steele Prairie State Preserve near Larrabee, Iowa would protect 85% of the plants in this section. Each of these three sites are protected in public ownership (USFWS 1996). Furthermore, the recovery plan placed the population at Pipestone National Monument at 38 plants or 7% of the plants in the section. However, the 2002 count of 221 flowering plants, which did not account for vegetative plants, suggested that Pipestone National Monument may actually support the largest population of western prairie fringed orchids in the section.

Despite the importance of the orchid population at Pipestone National Monument, the population faces several challenges. In the current agricultural landscape, the small population is not connected with a larger metapopulation. As a small population, severe and/or prolonged drought, lack of pollinators, herbivory, diseases, changes in plant community structure, invasive plant encroachment, and fire management, including exclusion or improper timing may reduce the population size or eliminate the population. Unfortunately, large-scale changes such as global warming, changes in groundwater hydrology, and aquifer contamination cannot be ruled out as possible threats to the population.

1c. Measurable objectives

This protocol focuses on measuring variables that serve as indicators of the most immediate management challenges: drought, fire, and pollination. The western prairie fringed orchid indicators that will be measured include: number of flowering plants, plant height, flower number, and fruit condition and number. Plant height serves as an indicator of general population health. Plant height and flower number may serve as indicators of plant physiological condition. Fruit number and condition serve as indicators of plant physiological condition, herbivory, and pollination rates. These indicators of plant condition are measured in relation to precipitation, soil moisture, prescribed fire, and plant community structure. Precipitation and soil moisture are measured to understand plant-soil relationships. Plant community structure, which is strongly related to fire in tallgrass prairies, may correspond with establishment site availability, nutrient availability, light availability, and soil moisture retention. Finally, plant phenology is monitored in order to relate precipitation, soil moisture, and prescribed fires to particular orchid life-stages.

There are two primary objectives for monitoring the western prairie fringed orchid at Pipestone National Monument:

3. Track temporal and spatial changes in the abundance and vigor (height, flowering, and fruit production) of flowering orchids at Pipestone National Monument in relation to fire, soil moisture, and precipitation.
4. Track changes in orchid habitat structure in relation to fire and precipitation

2. Sampling Design

2a. Rationale for selected sampling design

The erratic flowering of the western prairie fringed orchid and cryptic growth form of vegetative plants limit the ability to effectively monitor populations (Bowles 1983). A simple count of flowering plants, a highly detectable life stage, sufficiently meets monitoring objectives for the Pipestone population. Methods such as adaptive sampling and demographic monitoring that included vegetative plants have been tested at Pipestone National Monument and resulted in extensive trampling of orchid habitat. For this reason, monitoring will be limited to flowering orchids. Monitoring capsules provides an indication of pollination and reproduction rates.

2b. Site selection

Pipestone National Monument is a small (114-ha) national park unit in the Prairie Couteau region of southwestern Minnesota. Most western prairie fringed orchids are typically found in a mesic prairie in management unit 2B (26.7 acres). Orchid observations are also documented for a small portion of 3B (15.81 acres) and along the border between units 3 and 4. Defined search areas within units 2B and 3B were established based on the presence of orchid populations (Figure 3). In 2006, a single flowering orchid was found in the vicinity of the border between units 3 and 4. The area in the vicinity of the orchid will be searched during future monitoring to develop a third search unit. In the event that park staff identify additional orchids, corresponding search units will be delineated.

2c. Sampling frequency and replication

Orchid monitoring occurs annually and should be initiated approximately 7-10 days after the first flowers are observed. Capsule monitoring is completed annually following capsule formation, but prior to dehiscence. This normally occurs in late-August to early-September.

3. Field Methods

3a. Field season preparations and equipment set-up

Prior to each field season, the monitoring crew reviews the protocol, pre-trip information, and trip reports. All equipment and supplies should be prepared for the field season (SOP 1).

Beginning the last week in June, an area where western prairie fringed orchids are known to occur is inspected twice weekly by park staff for flowering orchids. An enlarging flower bud can be detected as early as one month prior to flowering (Bowles 1983). The locations of these plants are marked and the plants are observed regularly until anthesis. Orchids have been observed to bloom as early as the end of June, but flowering more typically begins during the first week in July. Orchid flowering typically peaks during the second or third week of July. Monitoring trips are scheduled to coincide with peak flowering.

3b. Sequence of events during field season

Orchid census methods are summarized here (see SOP 4). The search area in unit 2B is swept for flowering individuals by a crew of 3-7 individuals standing side-by-side and roughly 2 m apart. The search crew begins at one corner of the unit and moves north or south through the area until the search unit is covered. The boundary of the searched area is marked at regular intervals with wire flags. On the return sweep, flags are retrieved and new flags are placed along the boundary of the area searched. Unit 3B is typically only searched by one or two people. The pace of searching should be reasonably slow so that flowering orchids can be seen in the vegetation. Avoiding foot-dragging and limiting crowding around plants minimizes trampling. Following the survey, vegetation profile data are collected at nine locations in the orchid habitat. During the census, a subset of orchids is selected for capsule monitoring (SOP 5). Capsule monitoring is completed annually following capsule formation in late-August to early-September.

3c. Details of taking measurements

When a flowering orchid is encountered during the census, the location is recorded with a Trimble GeoXT GPS unit (see SOP 4). A second observer measures the plant height, the height to the base of the inflorescence, and the number of flower positions (flowers + buds). Attribute data and any comments about the condition of the flower are recorded in a data dictionary.

To collect vegetation profile data (see SOP 5) in the western prairie fringed orchid habitat, two observers navigate to each of nine points using the GPS navigation function (see SOP 3). At each point, one observer holds the cover board, while the second observer estimates the cover of vegetation using a modified Daubenmire cover class scale at three distances (5m, 10m, and 15m) in overlapping 0.5m height intervals.

During the census of flowering orchids, observers mark every tenth orchid for subsequent capsule monitoring (see SOP 7). In late-August or early-September, capsules on these plants were counted using the following categories: aborted, partially developed, fully developed. Capsule width and length are measured, as are plant height and height to the first capsule. Flags are removed after measurement. Characterization of plant and capsule condition includes field observations of herbivory, insect and fungal damage, malformation, etc. Over time, plant and capsule conditions will be defined based on these observations.

4. Data handling, analysis, and reporting

4a. Metadata procedures

Metadata will be generated using ESRI ArcGIS metadata tools. The generated metadata file will be stored in XML format and uploaded to the WASO NPS metadata and GIS data store. The federally threatened status of the western prairie fringed orchid requires that information access is restricted to NPS personnel, regulating agencies, or, with permission, NPS partners.

4b. Overview of database design

The following files are precursor files to databases or databases used to manage western prairie fringed orchid monitoring data:

Western prairie fringed orchid rover file – The file contains census information collected using the GPS data dictionary in the field. The file is differentially corrected using base station files.

Western prairie fringed orchid shapefile – The corrected rover file is exported as a shapefile using Pathfinder Office and appended to an existing shapefile that contains orchid location data for all years.

Western prairie fringed orchid database (WPFO_1.0.mdb) – The database contains three tables: one table with many of the attribute fields from the shapefile (plant height, height to base of inflorescence, number of flower positions), one table with plant measurements made during capsule monitoring, and one table with capsule measurements made during capsule monitoring.

Habitat database (PIPE_Habitat.mdb) – The habitat database includes daily precipitation data from National Weather Service station 216565, soil moisture data from the local monitoring station, and vegetation profile data.

4c. Data entry, verification, and editing

Census data are entered directly in to the GPS unit and eventually exported as a shapefile. The table tbl_Orchid in WPFO_1.0.mdb is updated annually by importing the .dbf file associated with the shapefile. Information collected during capsule monitoring is entered directly in the tbl_Capsules and tbl_Orchids_Capsules. The core western prairie fringed orchid habitat data are stored in the table tbl_Precip in the database PIPE_Habitat.mdb. The tables are updated annually by importing the text file of the most recent precipitation data in to the database and then appending the data to tbl_Precip. Soil moisture data are downloaded from the local station as an Excel file and appended to tbl_SoilMoisture. Vegetation profiled data are appended to tbl_VegProfile. Data verification and editing follow established network procedures (SOP 7)

4d. Recommendations for routine data summaries and statistical analyses to detect change

Recommended annual data summary routines using flowering orchid census data, capsule data, and precipitation data generated with Access queries include:

1. Number of flowering (reproductive) orchids.
2. Mean plant height.
3. Mean flower number per plant.

4. Mean capsule number per capsule-producing plant.
5. Mean ratio of capsules to flowers.
6. Mean capsule width and length.
7. Annual precipitation data and soil moisture are grouped to correspond with orchid life-history stages (see SOPs 6 and 8).
8. Mean vegetation cover for vegetation profile strata.

The following calculations are made based on records in the database:

1. Percentage of plants producing capsules.
2. Percentage of plants in various conditions.
3. Percentage of capsules in various conditions.

4e. Recommended reporting schedule

Reports will be prepared and distributed by May of the next calendar year.

4f. Recommended reporting format with examples of summary tables and figures

The report will follow the standard format required in the CBE Style Manual (1994). The natural resource technical report template for NPS documents is also required. An example of maps representing the distribution and abundance of flowering orchids at Pipestone National Monument is shown in Figure 4. A table summarizing census data and capsule monitoring data are shown in Tables 1 and 2, respectively.

4g. Recommended methods for long-term trend analysis

Long-term analysis will include graphing plant measurements over time.

4h. Data archival procedures

Editing of archived data is accomplished jointly by the project manager and data manager. Data archival procedures follow established network procedures (SOP 7).

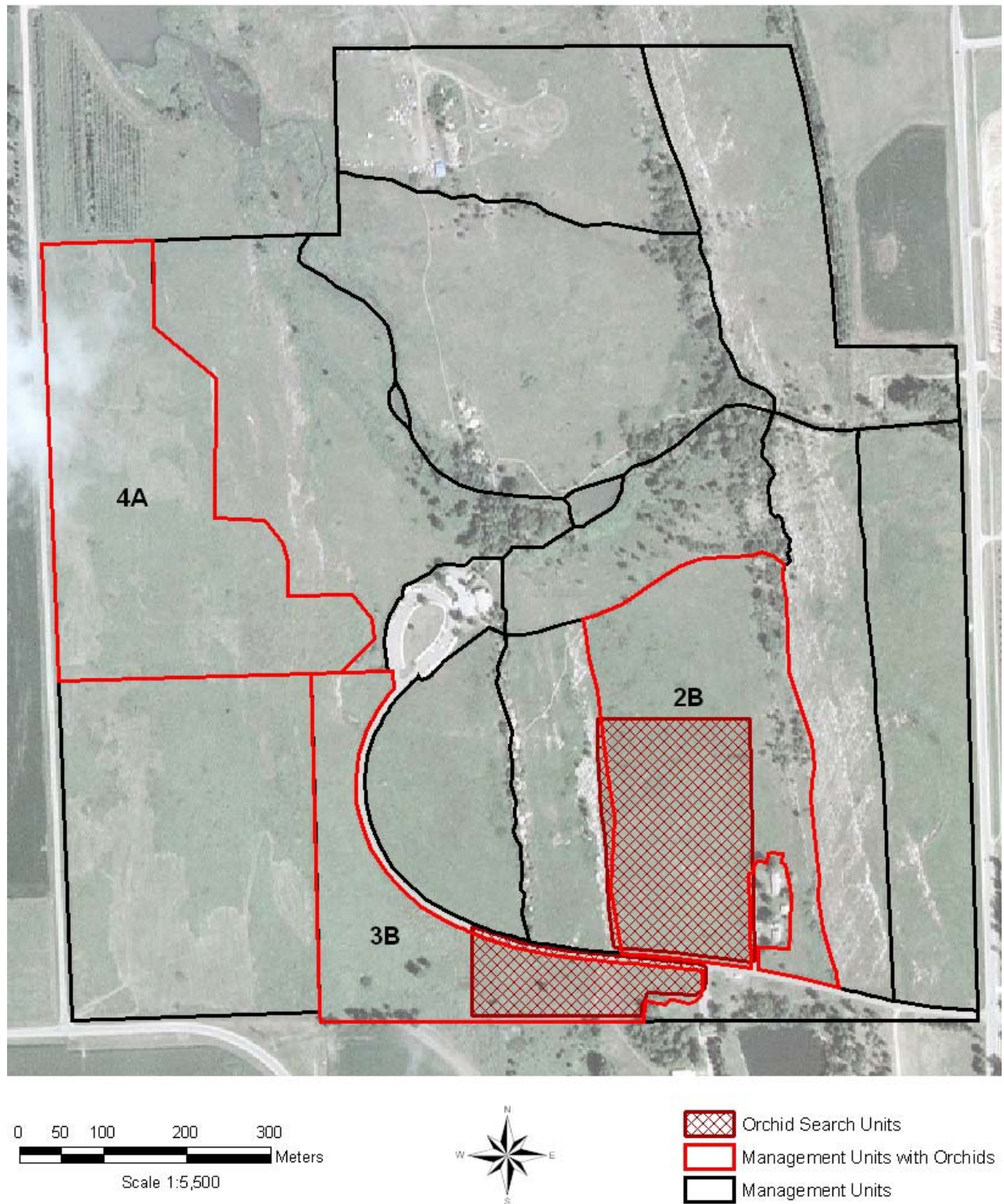


Figure 3. Western prairie fringed orchid search units within management units 2B and 3B at Pipestone National Monument.

Table 1. Number of flowering individuals, mean plant height, and mean number of flowers and buds per plant in the western prairie fringed orchid population at Pipestone National Monument, 1993-1996.

Year	Years since Rx fire	Flowering plants	Mean plant height (cm) \pm 1 standard deviation	Mean flowers/buds \pm 1 standard deviation
1993	1	33	59.5 \pm 7.9	9.4 \pm 3.3
1994	0	18	57.3 \pm 10.4	8.8 \pm 4.3
1995	1	37	61.4 \pm 7.3	9.5 \pm 3.1
1996	2	55	60.0 \pm 8.9	8.9 \pm 3.7
1997	0	3	38.7 \pm 5.4	9.3 \pm 2.6
1998	1	0	0	0
1999	2	16	55.1 \pm 9.9	7.9 \pm 2.6
2000	3	125	47.2 \pm 7.8	8.1 \pm 3.2
2001	4	95	51.3 \pm 8.2	7.7 \pm 2.1
2002	0	124	37.4 \pm 6.9	8.3 \pm 3.6
2003	1	221	55.9 \pm 8.5	8.3 \pm 2.8
2004	2	146	53.8 \pm 8.2	7.3 \pm 2.8
2005	3	149	52.8 \pm 9.3	7.0 \pm 2.4
2006	4	101	44.7 \pm 7.0	7.7 \pm 2.4

Table 2. Plant and capsule condition for western prairie fringed orchids selected for capsule monitoring.

Condition	2005 (n=49)	2006 (n=11)
Plants producing >1 capsule	76.0%	36.4%
Plants browsed	6.1%	0.0%
Plants desicated	0.0%	45.5%
Plants missing	10.2%	9.1%
Capsule:flower ratio for capsule producing plants \pm 1 s.d.	110.3 \pm 57.2 %	83.9 \pm 27.0 %
Capsules per plant for capsule producing plants \pm 1 s.d.	7.0 \pm 2.7	7.5 \pm 2.4
Aborted capsules	1.1%	20.0%
Insect- or fungi-damaged capsules	7.5%	0.0%
Capsule width \pm 1 s.d. (cm)	4.2 \pm 1.6	2.0 \pm 1.4
Capsule length \pm 1 s.d. (cm)	24.5 \pm 3.8	16.3 \pm 4.0

5. Personnel Requirements and Training

5a. Roles and responsibilities

The network botanist serves as the project manager and normally as the crew leader for western prairie fringed orchid monitoring. The network coordinator supervises the botanist. The data management aspect of the monitoring effort is the shared responsibility of the project manager and the data manager. Typically, the project manager oversees data collection, data entry, data verification and validation, as well as data summary, analysis, and reporting. The data manager designs the database and oversees data security, archiving, and dissemination. The data manager, in collaboration with the project manager, also develops data entry forms and other database features to assure data quality and to automate report generation. The data manager is responsible for building adequate QA-QC procedures into the database management system and for following appropriate data handling procedures.

5b. Qualifications

A competent, detail-oriented observer is essential for collecting credible, high-quality rare plant data. Overlooking plants decreases the ability to detect trends in plant abundance and distribution through time. Field observers must be proficient at accurately identifying the western prairie fringed orchid in a matrix of grass. Field observers must also be skilled with GPS navigation and data collection. Observers should be well-organized, work well as a team member, be comfortable in the field, and work methodically under difficult conditions.

5c. Training procedures

Training is essential for developing competent observers. Observers will review orchid identification using keys and photographs. The crew leader will provide a refresher on GPS data collection and orchid measurements.

6. Operational Requirements

6a. Annual workload

The census requires a five- to eight-person crew annually. Capsule monitoring requires a two-person crew. The census and capsule monitoring each require one field day. Data management and report writing require 15-20 staff days annually.

6b. Facility and equipment needs

A GPS receiver and basic field equipment are required to complete monitoring.

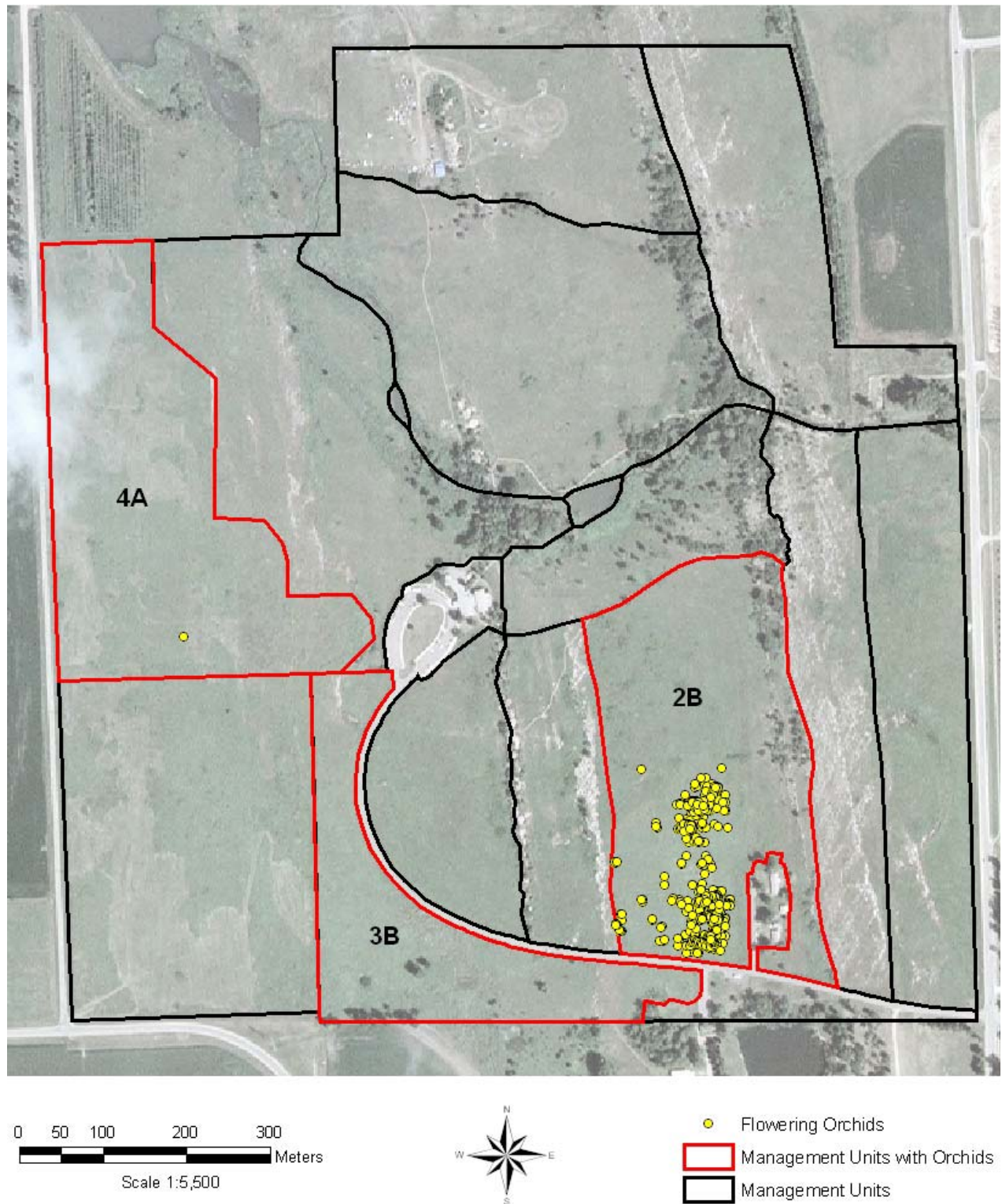


Figure 4. Distribution of flowering western prairie fringed orchids at Pipestone National Monument, 1993-2006.

6c. Startup costs and budget considerations

Personnel expenses for field work are based on a crew of two botanists. Assistance from three to five park staff or other partners is required. Data management requires staff time of biological science technicians, project manager, data management staff, quantitative ecologist, and the network coordinator. Startup costs include the purchase of equipment and supplies as well as maintenance or replacement of equipment shared among multiple projects (e.g., GPS units, cameras, vehicles).

Table 3. Estimated startup costs and annual budget for western prairie fringed orchid monitoring.

Category	Cost
Field work (salary)	\$2000.00
Travel	\$800.00
Data Management-Reporting	\$8,000.00
Startup Equipment Costs	\$8,500.00
Annual Equipment-Supplies	\$800.00
Administrative Support and Overhead	\$1000.00
TOTAL	\$21,100.00

7. References

- Bowles, M.L. 1983. The tallgrass prairie orchids: *Platanthera leucophaea* (Nutt.)Lindl. and *Cypripedium candidum* Muhl. ex Willd.: some aspects of their status, biology, and ecology, and implications toward management. *Natural Areas Journal* 3(4):14-37.
- Bowles, M.L. and A. Duxbury. 1986. Report on the status of *Platanthera praeclara* Sheviak & Bowles in Oklahoma, Kansas, Nebraska, South Dakota, and North Dakota. Unpublished Report to U.S. Fish and Wildlife Service, Denver, Colorado. 42 pages + appendices.
- Bray, T.E. and B.L. Wilson. 1992. Status of *Platanthera praeclara* Sheviak&Bowles (western prairie fringed orchid) in the Platte River Valley in Nebraska from Hamilton to Garden counties. *Transactions of the Nebraska Academy of Sciences* 19:57-62.
- CBE Style Manual Committee. 1994. Scientific style and format: the CBE manual for authors, editors, and publishers. Sixth edition. Council of Biology Editors, Cambridge University Press, New York, New York, USA.
- Dressler, R.L. 1981. The orchid: natural history and classification. Howard University Press, Cambridge, Massachusetts. 332 p.
- Knapp, A.K. and T.R. Seastadt. 1986. Detritus accumulation limits productivity of a tallgrass prairie. *Bioscience* 36:662-668.

Oakley, K.L., L.P. Thomas, and S.G. Fancy. 2003. Guidelines for long-term monitoring protocols. *Wildlife Society Bulletin* 31(4): 1000-1003.

Pleasants, J.M. 1995. The effects of spring burns on the western prairie fringed orchid (*Platanthera praeclara*). *Proceedings of the 14th North American Prairie Conference*. B.C. Hart, editor. Kansas State University Press. Manhattan, Kansas. p. 67-73.

Sather, N. and W. Smith. 1994. Results of demographic studies at four Minnesota populations of *Platanthera praeclara* in Minnesota. Presentation at Western Prairie Fringed Orchid Workshop, June 26-27, 1994, Crookston, Minnesota.

Sheviak, C.J. and M.L. Bowles. 1986. The prairie fringed orchids: a pollinator-isolated species pair. *Rhodora* 88:267-290.

Sharma, J., Zettler, L. W., Sambeek, J. W. Van, Ellersieck, M. R. & Starbuck, C. J. 2003. Symbiotic seed germination and mycorrhizae of federally threatened *Platanthera praeclara* (Orchidaceae). *American Midland Naturalist* 149:104-120.

Sieg, C.H. and A.J. Bjugstad. 1994. Five years of following the western prairie fringed orchid (*Platanthera praeclara*) on the Sheyenne National Grassland, North Dakota. In: Wickett, R.G., P.D. Lewis, A. Woodliffe, and P. Pratt (editors). *Proceedings of the 13th North American Prairie Conference*. August 6-9, 1992, Windsor, Ontario, Canada. Preney Print and Litho, Inc. p. 141-146.

Sieg, C.H. and R.M. King. 1995. Influence of environmental factors and preliminary demographic analyses of a threatened orchid *Platanthera praeclara*. *American Midland Naturalist* 134(2):307.

Sieg, C.H. and P.M. Wolken. 1999. Dynamics of a threatened orchid in flooded wetlands. *Proceedings of the North American Prairie Conference* 16:193-201.

U.S. Department of Agriculture (USDA). 1999. Management Guidelines for the Western Prairie Fringed Orchid on the Sheyenne National Grassland. Forest Service. U.S. Forest Service, Bismark, North Dakota.

U.S. Fish and Wildlife Service. 1989. Endangered and threatened wildlife and plants: determination of threatened status for eastern and western prairie fringed orchids. *Federal Register* 54(187):39857-39862.

U.S. Fish and Wildlife Service. 1996. *Platanthera praeclara* (western prairie fringed orchid) recovery plan. U.S. Fish and Wildlife Service, Ft. Snelling, Minnesota. 99 pages + appendices.

Willson, G.D., M.J. Page, and F.A. Akyuz. In preparation. Precipitation and fire effects on flowering of a rare prairie orchid.

Wolken, P.M., C.H. Sieg, and S.E. Williams. 2001. Quantifying suitable habitat of the western prairie fringed orchid. *Journal of Range Management* 54:611-616.

Western Prairie Fringed Orchid Monitoring Protocol
Heartland I&M Network and Prairie Cluster Prototype Monitoring Program

Standard Operation Procedure 1: Field Work Preparation

Version 1.00 (07/01/2007)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

I. Procedures

1. Prior to the field season each year, all observers should review the entire protocol, as well as pre-trip and post-trip reports.
2. The project manager records observer names, travel hours, field hours, and field notes.
3. The project manager provides an overview of project scope and methods. Prior to sampling, the project manager will provide a map of the search area.
4. Equipment should be checked prior to sampling to provide sufficient time for ordering and repairing equipment. The following equipment is needed:

Western prairie fringed orchid census

- Trimble GeoXT GPS units with data dictionary and search areas (x2) (Figure 1)
- Laptop computer with Pathfinder software, data dictionary, navigation files, and shape files
- Handheld counter (Figure 2)
- Meter sticks with cm markings (x2) (Figure 3)
- Digital camera
- Flagging
- Large wire flags (x50) (Figure 4)
- Small wire flags (x50) (Figure 4)
- Maps (optional)

Vegetation profile monitoring

- Vegetation profile board (Figure 5)
- Sighting pole (Figure 5)
- 50-m tape

Western prairie fringed capsule monitoring

- Meter stick with cm markings (x2) (Figure 3)
- Vernier calipers (Figure 5)
- Data sheets (see SOP 5)
- Clipboard

Miscellaneous items

- First aid kit
- Radios
- Sun screen
- Insect repellent
- Water

5. The data dictionary and search unit files are located on the network server.
6. In early July, the project manager will communicate with the park manager for a report on orchid flowering status. In most years, peak flowering occurs during the second or third week of July.



Figure 1.1. Trimble GeoXT GPS unit



Figure 1.2. Handheld counter

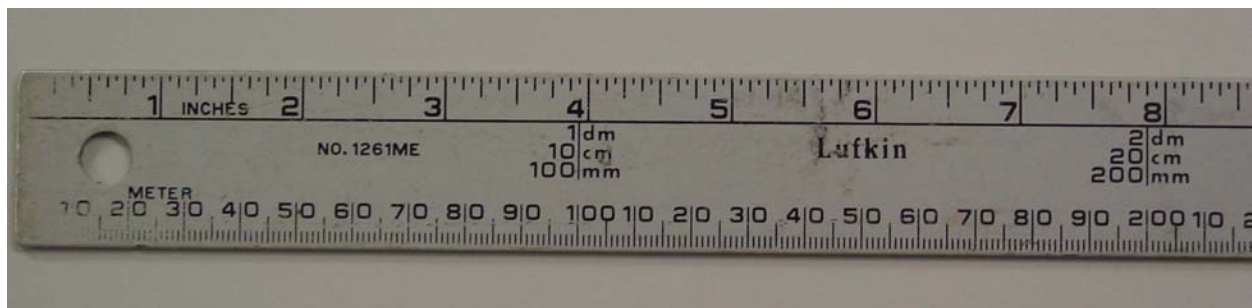


Figure 1.3. Meter stick with cm markings

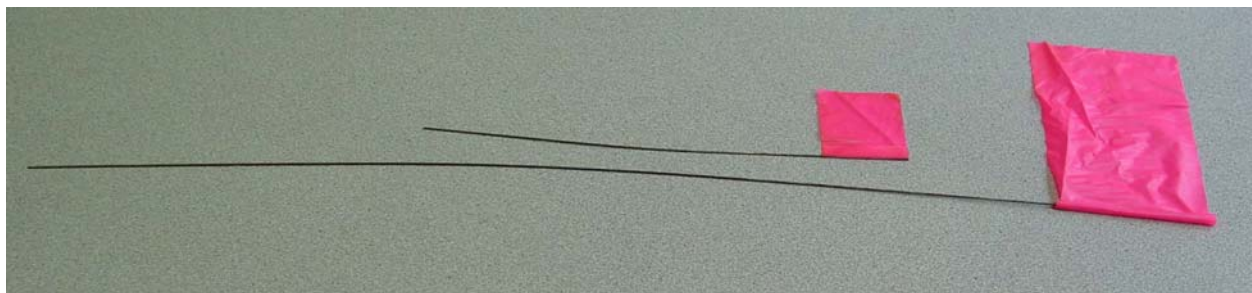


Figure 1.4. Large and small wire flags

Figure 1.5. Vegetation profile board.

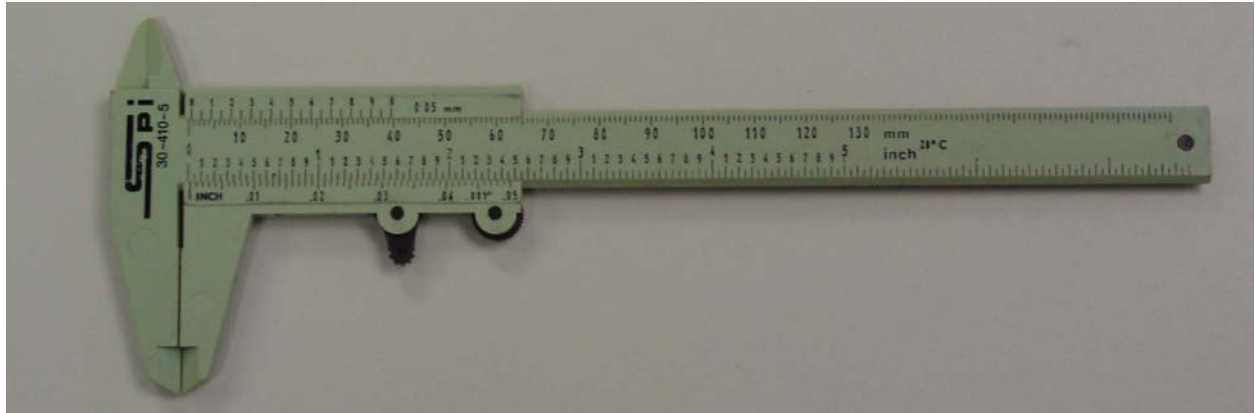


Figure 1.6. Vernier calipers

Western Prairie Fringed Orchid Monitoring Protocol
Heartland I&M Network and Prairie Cluster Prototype Monitoring Program

Standard Operation Procedure 2: Training

Version 1.00 (07/01/2007)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

I. Identification of the Western Prairie Fringed Orchid

Observers should study photographs and read descriptions of the orchid in flowering and vegetative condition prior to field work. Observers should spend time examining flowering orchids in the field at Pipestone National Monument.

II. Search Logistics

Prior to visiting the field, observers need to understand search logistics to work as a team to ensure that the sweep is continuous across the prairie. Care should be exercised to minimize trampling. Observers must be cognizant that the search pace should not exceed the pace at which the GPS operator(s) can collect data. The search line should be relatively straight and observers should wait for the entire line to move rather than each observer moving independently. Patience is required.

III. GPS

GPS operators must receive training prior to data collection in the field. Training is expected to last 15 to 20 minutes. Observers must understand how to collect a position, how to stop collection of a position, where to hold the GPS unit during collection, and how to enter data using the data dictionary. Collection of several points should be practiced to ensure that operation is successful.

IV. Orchid Measurements

Measurement of plant height, flower counts, capsule measurement, plant condition assessment, and capsule condition assessment should be reviewed.

This page intentionally left blank.

**Western Prairie Fringed Orchid Monitoring Protocol
Heartland I&M Network and Prairie Cluster Prototype Monitoring Program**

**Standard Operation Procedure 3:
Using the Trimble GeoXT (TerraSync version 2.5)**

Version 1.00 (07/01/2007)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
1.0	Dec. 2004	J. Haack	Pages 18-34	New version of TerraSync	1.01
1.01	Apr. 2006	J. Haack	Entire document	Troubleshooting and log	1.02
1.02	Oct. 2006	J. Haack	Pages 32-33	Add map displays, XT	1.03
1.03	Nov. 2006	C. Young	Excerpted GeoXT info	Focus for protocol	2.00

This Standard Operating Procedure explains the procedures that all observers should follow to learn to use Global Positioning System (GPS) for the GeoXT units to collect data and navigate to sample sites. Included is a discussion of PDOP (proportional dilution of precision) and a measure of GPS accuracy. GPS collection should only occur when the PDOP value is less than six. High PDOP typically reflects a combination of poor satellite geometry and scatter due to atmospheric conditions. Quickplan charts can be used to identify times of high PDOP, thus times to avoid collecting GPS data. See “Scheduling Field Days” below.

I. Required Reading

GeoExplorer CE Series: Getting Started Guide

GPS Mapping for GIS with TerraSync and GeoExplorer CE Series or TerraSync Operation Guide v2.50

Basic GPS Data Capture Using TerraSync: A Quick Start Guide

II. Scheduling Field Days

For your GPS unit to function properly and collect accurate geographic locations there must be at least four satellites overhead and preferably more. In addition, PDOP (the measurement of relative accuracy) must be less than six. Schedule your field work at a date and time when the PDOP value is below six and the number of available satellites is at least four. In order to facilitate your data collection, ask the GIS Coordinator if the most current almanac is available. The almanac is a set of data that is used to predict satellite orbits over approximately a month long period.

Accessing Current Almanac

You may access it the same way you did with the Trimble Pro XR and GeoExplorer 3 in Pathfinder, or you can open TerraSync on the GeoXT and choose *Status* in the upper left corner drop down menu (Figure 3.1). Then choose *Plan* in the dropdown menu below it. It will give you the PDOP and satellite orbits for up to 12 hours.

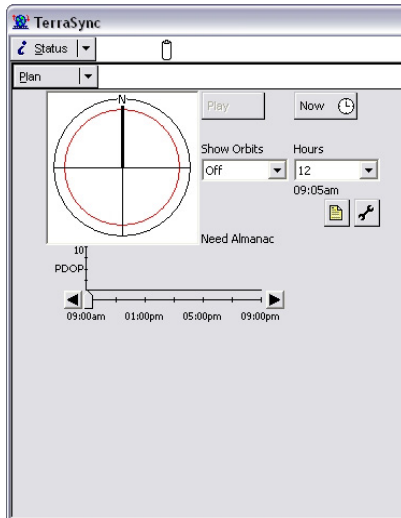


Figure 3.1. Accessing the current almanac on the GeoXT GPS Unit.

III. Pre-Trip Planning

Route Planning

It is essential to plan your route. When you are recording data, having knowledge of the area may allow you to maximize your time by allowing you to work on several features on the same trip. In addition, the topography of the area where you are collecting data may require changes in the GPS configuration. The GIS coordinator will help you with any changes. Knowing where features are located will help you prepare the GPS for recording information in the field.

Pathfinder Office allows you to create a form for data collection in the GPS. This is accomplished by preparing Data Dictionaries in Pathfinder Office. They are then transferred to the GPS for your field work. When you return from the field, the information you recorded with the GPS is downloaded to the computer. The GIS Coordinator is then able to export the information directly into ArcGIS as a table.

Data Dictionaries

See Appendix with definitions for terms with which you are unfamiliar.

1. Open Pathfinder Office and click on *Utilities* and select *Data Dictionary Editor*.
2. Name the file – this will be the name for the data dictionary file you are creating. (Examples: PipeFishSampling, MoBladDemo, or DeerSurvey) Also, fill in the *comment* box with what project this data dictionary is for.
3. Click on *New Feature* and select the *Properties* tab enter a feature name. Feature names should correspond with fieldnames from each project database. (Examples: pool, deer

location, or plot) Next designate the feature as a point, line or polygon. Next click on the *Default Settings* tab, change the logging interval to 1 second. Then click *OK*. If later you need to go back and edit one of the settings you just created, highlight the feature and click on *Edit Feature*. You may also create more than one feature per data dictionary.

4. To define attributes you wish to record in the field for the feature, click on *New Attribute* and select which attributes you want from the list of *New Attribute Type* (listed below) then click *Add*.
 - a) Menu - letters, numbers, or other characters. Can select only one value per menu, but can have as many menus in the data dictionary as necessary. Menus are used for comment fields and name fields where you know all possible choices (example is a list of all possible tree species for a certain area or if you have a specific value range 1, 2, 3, 4, etc). Type in *Attribute Name* and click on *New*. Type in attribute value and click *Add*. These could be the names of attributes or measurements associated with attributes. Continue until all attribute values have been entered. Then click *OK*.
 - b) Numeric - numbers only, with decimal point (use for the id # and value amounts).
 - c) Text - letters, numbers or other characters. Can enter any value – use for the name field if you don't use a menu or comment/note area.
 - d) Date - collects a date value.
 - e) Time - collects a time value.
 - f) File Name - collects a file name.
 - g) Separator - are added to break up the list of attributes and increase readability, but are not attributes and do not contain attribute values.
5. Designate, for all attributes, whether the field entry of an attribute is optional (normal), required, or not permitted. Continue until all attributes have been entered.
6. Save data dictionary.

Field Material and Equipment

1. Notebook and pencil
2. GPS field guide (this document)
3. Watch
4. Water
5. Compass
6. Radio or cellphone
7. Bug repellent/sunscreen
8. GPS unit

IV. System Assembly And Settings

When the unit is not in use, it should be in its cradle on and charging. Remember to use the surge protector when the cradle is plugged in. If the unit will not be needed for more than 4 months, turn the unit off and store it in the closet.

GeoXT Unit Assembly

There is no assembly for the GeoXT (internal antenna) unless you are going to use the Hurricane Antenna or BoB (beacon on a belt). The assembly for the Hurricane Antenna is simple. First attach the antenna to the pole. Then attached the cable to the antenna. Finally plug cable into

the top of the GeoXT. The Hurricane Antenna is great for areas that have a lot of trees or topography. To use BoB you must attach the serial clip with the curly cable to the back of the GeoXT. The other end of the curly cable plugs into the bottom of BoB. Make sure that the GeoXT and BoB are both fully charged before going out and doing field work.

Configuring the GeoXT

In the drop down menu in the upper left corner select *Setup* (Figure 3.2).

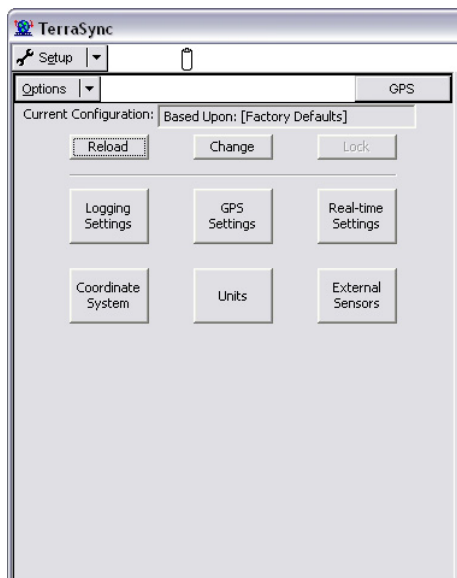
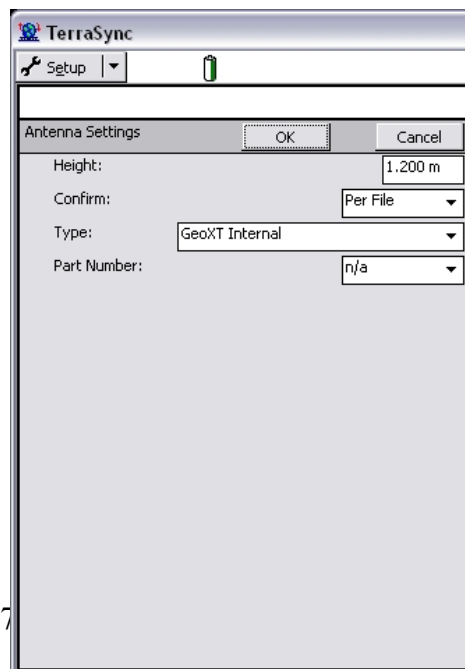


Figure 3.2. Drop down menu for setup for configuring the GeoXT.

The following changes to the factory defaults settings should be made:

1. In *Logging Settings* change *Antenna Height*, click the wrench button (Figure 3.3). The setting will differ depending on if the internal antenna or the Hurricane Antenna is being used. If internal change *Type* to GeoXT Internal and *Height* to 1.2m (Figure 3.4). If Hurricane change *Type* to Hurricane, *Part Number* to 50393-50, and *Height* to the correct measurement for the person working the GPS unit (Figure 3.5).



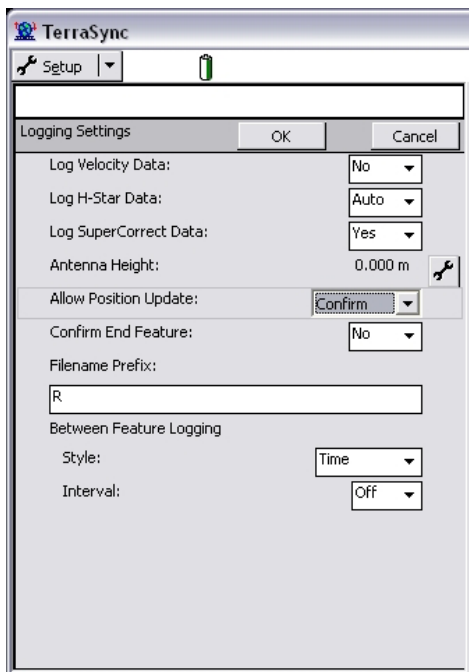


Figure 3.3. Logging settings menu for GeoXT.

Figure 3.4. Antenna settings for the GeoXT internal antenna.

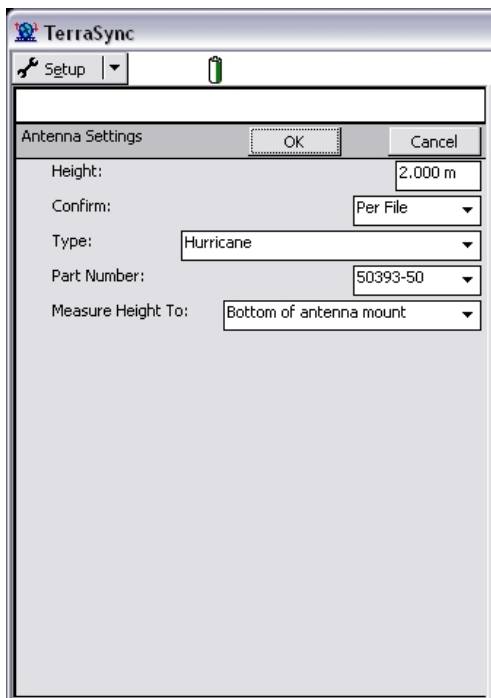


Figure 3.5. Antenna settings for the Hurricane Antenna.

2. In *GPS Settings* change defaults to those seen in Figure 3.6. For the WICR GeoXT the *GPS Receiver Port* is COM3. If collecting data positions never set the PDOP above 6.0.

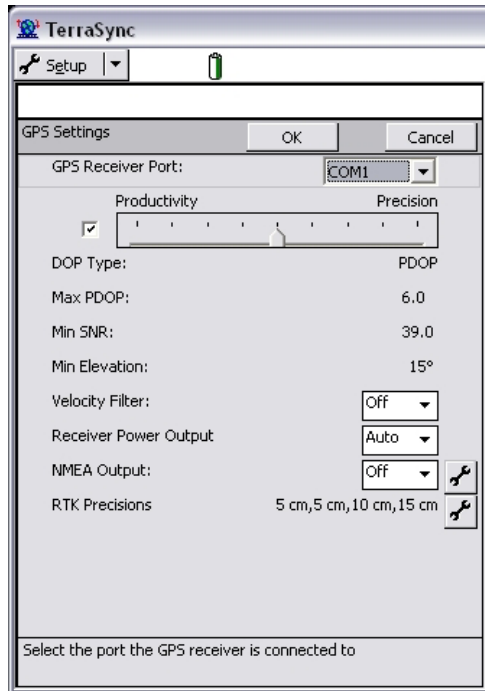


Figure 3.6. Recommended GPS settings for GeoXT.

3. The settings for *Real-Time Settings* depend on what the GPS is being used for. If navigating using a BoB change *Choice 1* to **External Source**. When navigating and want to real-time correct with the WAAS satellite differential service set *Choice 1* to **Integrated SBAS** (SBAS includes satellite services for many different areas, WAAS is the satellites for North America). If the GPS unit is being used for data collection set *Choice 1* to **Use Uncorrected GPS** (which is the default choice). The setting **Use Uncorrected GPS** is used because the data that is collected will be differentially corrected (post-processed) in the office by the GIS Specialist to get the most accurate data possible.
4. In *Coordinate System* set the choices seen in Figure 3.7. The *Zone* will change depending on what park you are working in. See table 3.3 below for correct *Zone*.

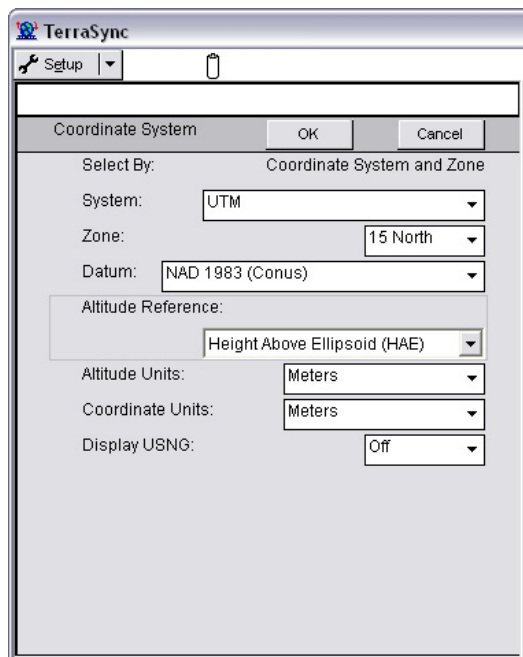


Figure 3.7. Coordinate system choices for the GeoXT.

Table 3.3. Zones for HTLN parks.

Park	UTM Zone	Datum
AGFO	13 North	NAD 1983 (Conus)
ARPO	15 North	NAD 1983 (Conus)
BUFF	15 North	NAD 1983 (Conus)
CUVA	17 North	NAD 1983 (Conus)
EFMO	15 North	NAD 1983 (Conus)
GWCA	15 North	NAD 1983 (Conus)
HEHO	15 North	NAD 1983 (Conus)
HOCU	17 North	NAD 1983 (Conus)
HOME	14 North	NAD 1983 (Conus)
HOSP	15 North	NAD 1983 (Conus)
LIBO	16 North	NAD 1983 (Conus)
OZAR	15 North	NAD 1983 (Conus)
PERI	15 North	NAD 1983 (Conus)
PIPE	14 North	NAD 1983 (Conus)
SCBL	13 North	NAD 1983 (Conus)
TAPR	14 North	NAD 1983 (Conus)
WICR	15 North	NAD 1983 (Conus)

5. In *Units* the following should be set as in Figure 3.8, below.

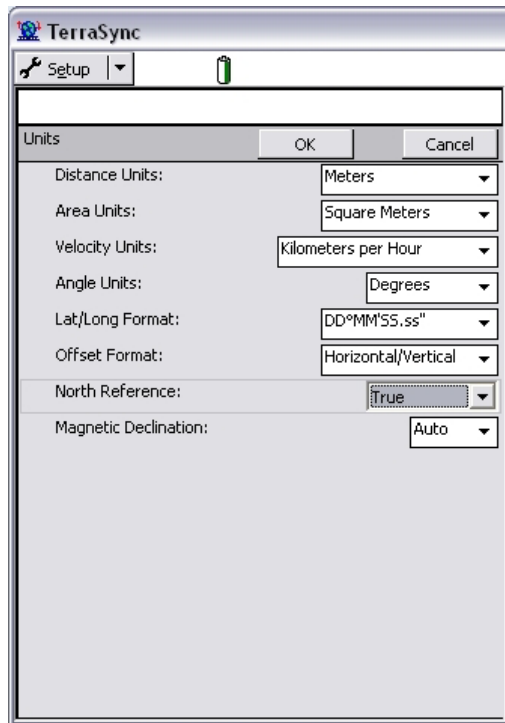


Figure 3.8. Suggested units for data collection with GeoXT.

6. In *External Sensors* nothing should be checked. The GIS Coordinator will have these settings already entered if they are needed. This menu is only needed if attaching a sensor or range finder to the GeoXT.

V. File Transfer

Pathfinder and Microsoft ActiveSync must already be loaded onto the PC.

1. Put the GeoXT into the charging cradle. Attach the USB cable to the charging cradle and to your PC.
2. Once you have the GeoXT locked into the cradle, Microsoft ActiveSync should automatically start. When a dialog box appears answer **Guest Relationship**.
3. Once Microsoft ActiveSync is green and running open Pathfinder Office.
4. In Pathfinder Office check to see if the coordinates are set correctly for the file(s) you are transferring. To do this click *Options, Coordinate System* and change anything that is incorrect.
5. Next in Pathfinder Office, click on *Utilities* and choose *Data Transfer*. A message will appear - *connecting to data logger*. This connection will either happen quickly or it will not work due to problems with the set up. If this occurs, check the cabling and your sequence of events. Also check that the cable is attached to the proper COM port. For the GeoXT this is *GIS Datalogger on Windows CE* (Figure 3.9).
6. Once the connection is made, check with the GIS coordinator that the source directory is correct.
7. If you are downloading data from the GeoXT make sure the *Receive* tab is active. If loading data onto the GeoXT the *Send* tab should be active.
8. Next click the *Add* button, then choose the correct file type (data, waypoint, data dictionary, etc.). You may choose more than one file at a time. When all files are chosen, click *Transfer All*.
9. When the transfer is done, click *Close* and then close all programs.

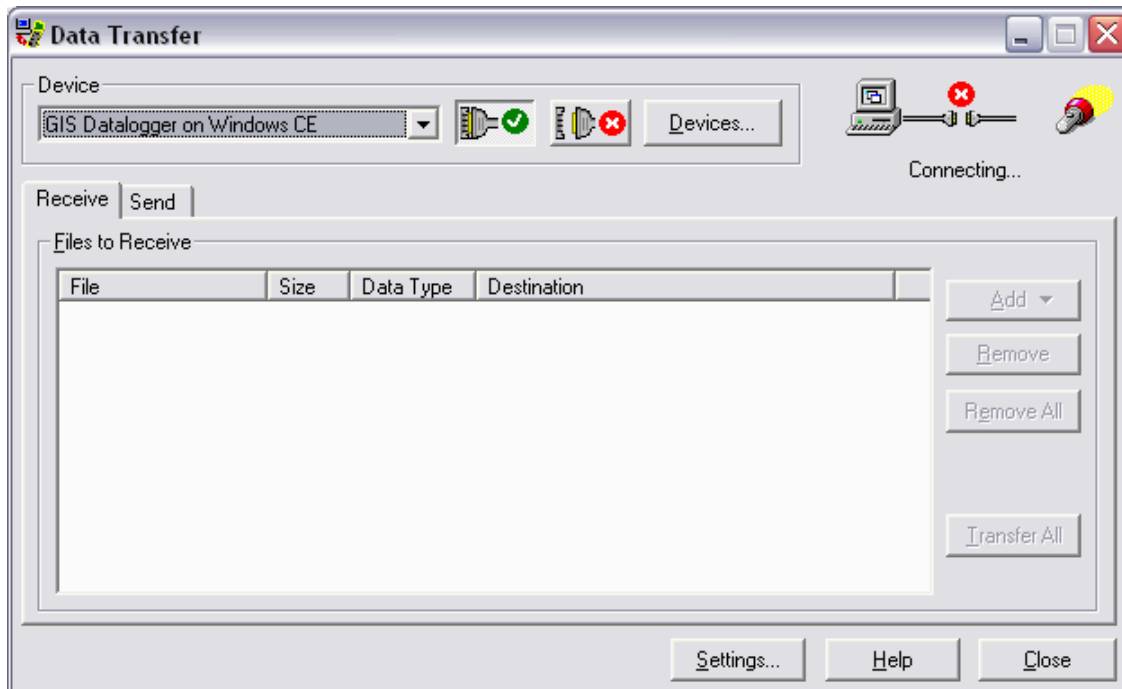


Figure 3.9. Picture of the Data Transfer window in Pathfinder Office.

VI. Data Capture

1. Open TerraSync on the GeoXT.
2. In the dropdown menu in the upper left select *Data*.
3. If creating a new data file select *New* in the second dropdown menu. In **File Name**, type a name with the keyboard option (make sure the park code and the year are part of the file name). Also, select the data dictionary that you want to use in the **Dictionary Name** dropdown menu. Always keep **File Type Rover** and **Location Default** as the defaults. Then click *Create*. If you are re-opening an existing data file instead of starting a new one, select *Existing File* instead of *New* in the second dropdown menu. When Choose Existing Data File screen appears, highlight the correct file and click *Open*.
4. Click the *Options* button and select *Logging Interval* and choose *1s*.
5. Now highlight the Feature Type that you want to collect and click *Create* (Figure 3.10).
6. Fill in the blank data dictionary or the comment field if using the generic data dictionary. If the Pause icon is flashing click the *Log* button to start collecting positions. You should now see a pencil writing and a number beside it, which is the number of positions collected thus far. Collect 50 positions for each point. Number of positions for lines and polygons will vary on the size of the feature. However, if making a polygon don't go past the starting point, as this will create more than one polygon when the software closes the polygon.
7. Click *OK* to finish collecting the feature.
8. If you want to collect another feature repeat steps 4-6. If done for the moment click *Close*.

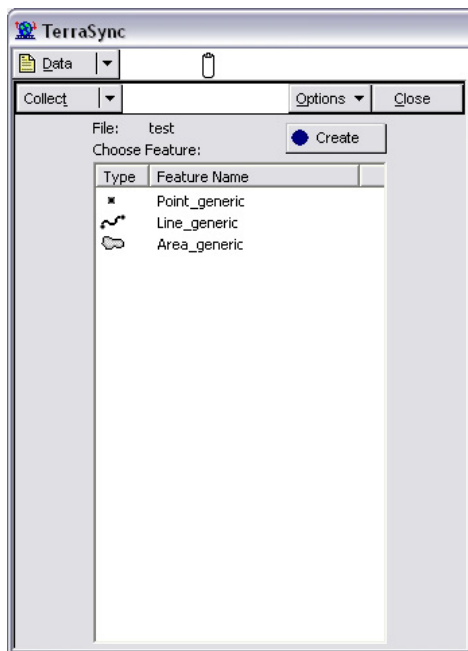


Figure 3.10. Three feature types available in TerraSync.

Special Data Capture Methods

Offsets

1. First, to offset you need to select either *Horizontal/Vertical* or *Slope/Inclination*, which is done in the **Setup, Units** window (Figure 3.11).
2. Then back in the **Data** window, after doing steps 1-6 in the Data Capture section, *pause* the position logging. Click *Options* and select *Offset*.
3. Depending on what offset choice was made (Figure 3.12), fill in the offset information (distance, bearing, etc.) and click *OK*. Then finish collecting the feature positions and click *OK* to finish the feature.

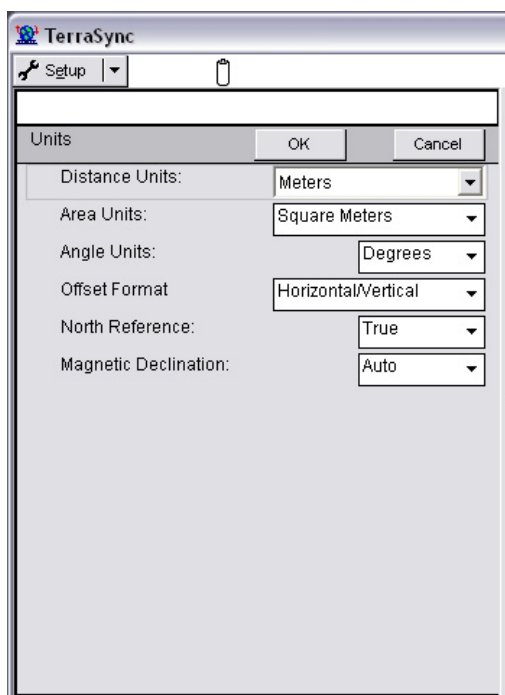


Figure 3.11. Checking offset format in the Setup>Units window.

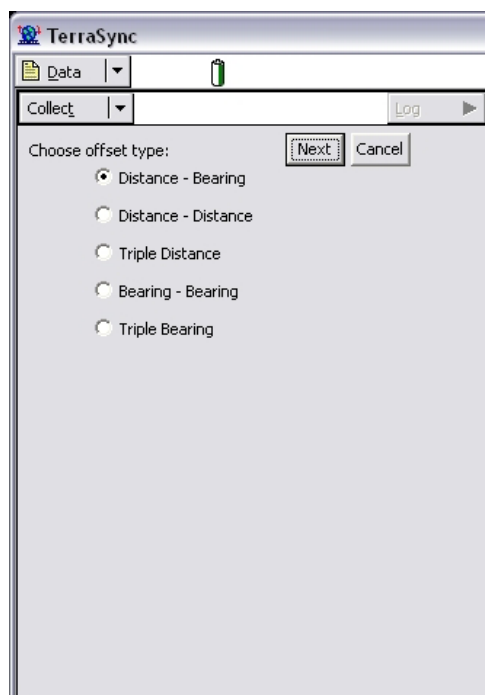


Figure 3.12. Data collection offset options.

Segmenting a Line

While in the process of collecting a segmented line, for example a trail that is part gravel and part paved, you do not want to collect two different features that don't connect. With the Segmenting Line feature, you can attribute segments along the line. When you come to the spot along the line that you want to attribute differently, click *Options* and select *Segment Line*. The logging positions start over and you are able to rename the line in the comment box. When you are done collecting the feature click *OK*.

Continue

This function lets you pick up a line and add to it after it was closed. You just need to be in the Data Collect window (figure 3.10), click *Options* and select *Continue*.

VII. Navigation

1. First you must have a file on the GeoXT that you can navigate to (usually a waypoint file).
2. Next open TerraSync and open the Data window. Highlight the file you want, click *Open*.
3. Then highlight the feature you want to navigate to, click *Options* and select *Set Nav Target*. The icon under the Name column should turn into two flags crossed over each other (Figure 3.13).
4. Now in the upper left hand corner dropdown box select *Navigation*. You now see a window that gives you bearing, heading, distance, and arrow so you can navigate to your feature.
5. To deselect the navigation target, go back to the Data window, click *Options* and select *Clear Nav Target*.

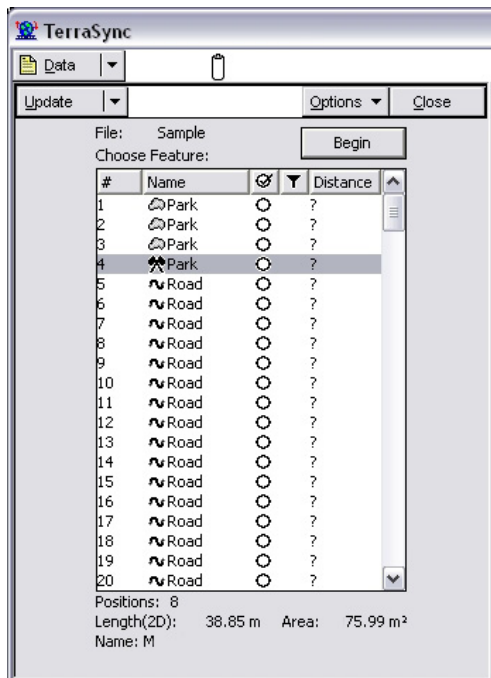


Figure 3.13. Example of crossed flags icon when feature is selected for navigation.

VIII. Map Display

You can display background files or data files in the Map window. The files will be load onto the GeoXT by the GIS Coordinator.

1. First select *Map* in the upper left hand dropdown box.
2. Click *Layers* and select *Background File*.
3. Depending on if you are displaying a background or a data file, click the dropdown menu for *File Type* and select the one you want to use. (Data files examples: waypoint and rover files).
4. Highlight the file you want to display and click *OK*.
5. Your file is now displayed, use the map function buttons to zoom in and out and pan (Figure 3.14).

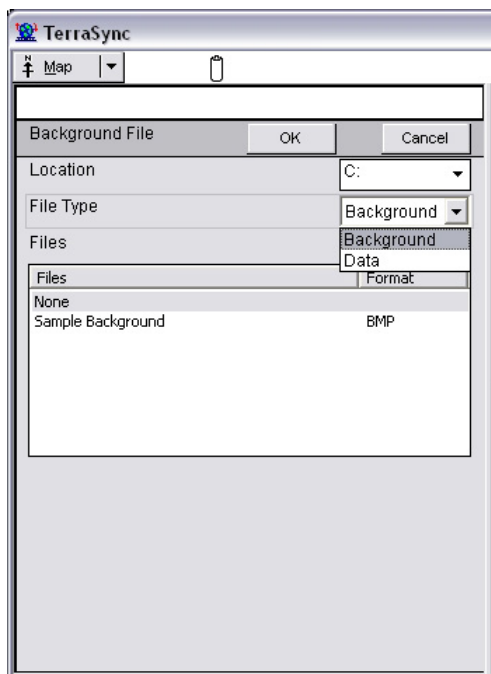


Figure 3.14. Map function buttons on GeoXT.

Entering Coordinates

If the need to hand enter coordinates occurs it is also done in the Map window.

1. First create or open an existing file (see data capture).
2. Open the Map window, click on the *Tools* dropdown menu and select *Digitize* (Figure 3.15).
3. Next click on *Options* and select *Enter Coordinates*.
4. Enter the coordinates and then click *OK* (Figure 3.16).

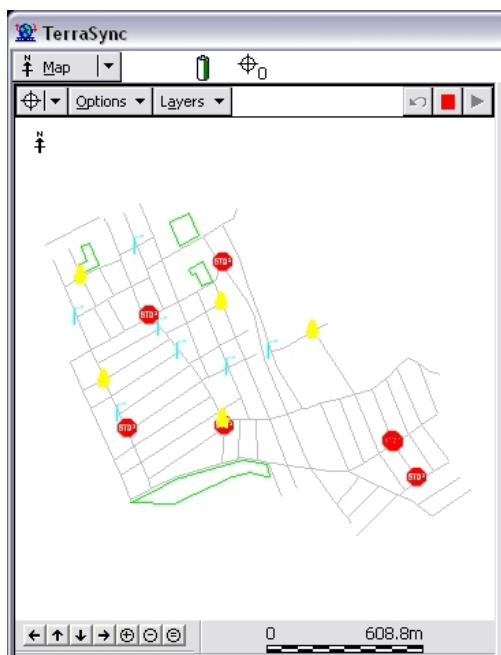


Figure 3.15. Display of the Map window with digitizing tool selected.

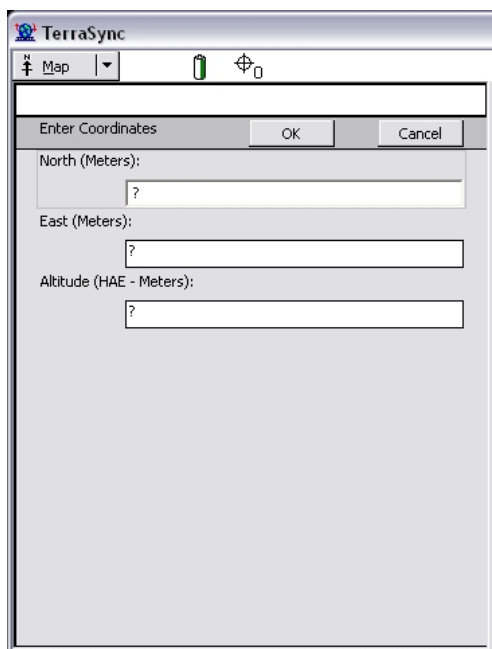


Figure 3.16. Display for entering coordinates.

Creating an Image Map Display

This step is for displaying a raster, such as a DOQQ or an ArcMap project with multiple layers, on the GeoXT screen. It is important to note that when displaying the ArcMap project that it will show as just one layer and not the multiple layers that could be used to create the project.

Plain Raster File

The type of raster files that can be displayed in TerraSync are .bmp, .tif, .jpg, and .sid (GPS Pathfinder Office help). Some raster datasets cover a large area. If only a small sections of the raster is needed clip the image in either ArcGIS or ERDAS Imagine to save space on the GPS unit. Remember a world file is needed with every raster file loaded onto the GPS unit. For help on creating a world file see the GPS Pathfinder Office help index.

ArcMap Project Display

1. Create your project in ArcMap.
2. In the printer setup selection choose: Microsoft Office Document Image Writer.
3. In the layout display fit the data frame to margins. Note: Do not add legend, north arrow, etc. to the layout.
4. Export the layout as a .tif with 300 dpi.
5. If the image needs to be cropped, so that there is no white border around the image, do this in Adobe Photoshop.
6. Bring your newly created .tif file into ArcMap and rectify it using the Georeferencing toolbar. By rectifying the .tif in ArcMap a world file is automatically created.
7. Transfer the .tif to the GPS unit.



Figure 3.17. GPS map displays from an ArcMap project.

IX. Differential Correction

This is done using Pathfinder Office software after the rover file is transferred to the desktop computer. As with everything, before you start double check that the coordinate system is correct.

1. Click on *Utilities*, choose *Differential Correction*.
2. Browse for the rover file that you want to correct.

3. Click *Internet Search, New*.
4. Select Copy the most up-to-date list from Trimble's Internet site, and select from it, click *OK*. Under confirm setup click *Yes*.
5. Highlight the base provider that is closest with a good integrity index (write down the base provider information so that it can be put in the metadata later), click *OK*.
6. When base provider of the same name already exists, you will receive a message "Overwrite existing base provider?" click *Yes*.
7. Provider Properties, click *OK*.
8. In the Confirm Selected Base Files box, click *OK* if you have a 100% coverage. If not repeat steps 5-7, with the next closest until you get 100%.
9. Reference Position leave default values and click *OK*.
10. Make sure the output folder is correct, and click *OK*.

X. Exporting To Shapefiles

Check to see if coordinate system is correct.

1. In Pathfinder Office click on *Utilities*, choose *Export*.
2. Browse to the file that needs to be exported. Also, make sure that the output folder is correct. Click the *Properties* button then click the *Attributes* tab. The following should be checked: **All Feature Types** – PDOP, Correction Status, Receiver Type, Date Recorded, Time Recorded, Update Status, Data File Name, Filtered Positions, Data Dictionary Name; **Line Features** – Length (2D), Average Horiz. Precision, Worst Horiz. Precision; **Point Features** – Horizontal Precision, Standard Deviation, Position; **Area Features** – Area (2D), Average Horiz. Precision, and Worst Horiz. Precision. Click *OK*. Click *OK* again in the Export box, when everything is set.
3. Once a shapefile is exported you will want to rename that file right away using ArcCatalog. The default is a generic name such as point_ge or the name from the data dictionary. If you are going to be exporting more than one file the previous one will be overwritten therefore, rename each file after each export.
4. After the shapefile is made, open ArcToolbox. Scroll to Data Management Tools; Projections and Transformations, and click on *Define Projection*. Browse to your file and set the coordinate system that you collected the feature in.
5. Then within ArcCatalog create metadata for your file.

XI. Troubleshooting

There will most likely be times when the GPS unit is not acting the way you wish it to. In some cases it might just be a bad time to collect data (low satellite number or high PDOP). The first thing to check when the GPS unit is not acting correctly is to check the battery power and the assembly of the unit. Every once in a while when toggling too fast between screen the XT's screen locks up, if it does not correct itself within a couple of minutes you will have to do a hard restart (by holding the power button down for 15 seconds). If you have collected data and not done a backup recently you may lose your data. If the GPS unit ever asks for the TerraSync installation code, this number is located on the case by the handle and also on a card inside the case. Type the number into the unit exactly how it is written, with dashes.

It is important to keep track of the problems that occur for each GPS unit. In every GPS unit box there is *Problem Log* sheets. When an issue occurs with a GPS unit it is important that this sheet is fill out and then given to the GIS coordinator. The problems are tracked to see if it is re-occurring in a certain unit. **It is important to note that even though parts are interchangeable between units, that you use only that units accessories.** (In the past this process helped identified a faulty cable) On the log sheet it is essential to fill out as much information as possible, such as user, date, unit number, steps taken before problem, error message, etc.

XII. Appendix A. Glossary of Terms Critical to Using a GPS Unit

Elevation Mask: Sets cut-off elevation for satellites (the unit will not gather positions from satellites lower than the degree set). This should be a minimum of one degree above the Base Station Mask with 15 degrees recommended. This is most important during the planning stages. If you are working in locations with obstructions you can set the mask higher so that only those satellites higher in the sky will be used for data collection. You can also allow for these situations by checking the azimuth position of satellites in Quick Plan.

SNR Mask: Signal strength or Signal to Noise Ratio. If it is too high you will not get good data. The range is 0-99. If you raise the SNR mask you can receive more satellites, but the data is not as good.

PDOP Mask: Position Dilution of Precision. It is an indication of the accuracy of the calculated position based on the location of the satellites in the constellation. If satellite positions do not allow the use of coordinate geometry, then accurate ground locations can not be triangulated from them.

Less than 4 = very good; 5 to 8 = adequate; more than 8 = stay home.

Julian Date: Day of the year between the range of 1 and 365. For example, the Julian Date for February 2 is #33. February 2 is the calendar date.

Feature: The units on which you collect data. Examples include buildings, woodlots, roads, trails, points, etc.

Attributes: Descriptive characteristics of features.

Points, Lines, and Polygons: Geographic terms related to scale that describe how features are drawn. Points are single dimensional, lines have length, and polygons have area.

Position(s): The number of signals received from the satellites that are used to make the GPS features. For point features collect 50 positions. Number of positions will vary for lines and polygons.

Differential Correction: Increases the accuracy of the data files by correcting errors associated with the signal received from the satellites. Also call post-processing. (See Pathfinder Office help – differential GPS).

BoB: Beacon-on-a-Belt is a real time correction receiver.

The F2 button on the GeoXT unit displays the battery power.

ICONS

For GeoXT



Real-time WAAS: The GPS is picking up real-time corrections from WAAS satellite.



Real-time BoB: The GPS is picking up real-time correction from the Beacon-on-a-Belt.



Battery power for the GPS.



Shows that the GPS is logging positions. The number is the amount of positions.



Digitizing: For drawing features or entering coordinates.



Data window.



Map window.



Navigation window.



Setup window.



Status window.



Real-time beacon: The GPS is able to receive real-time correction data from a beacon or base station.



Connection: The icon is showing no connection, when the two pieces are together there is a connection. This icon is seen when connecting the GPS to a computer in Pathfinder or when connecting the handheld unit to its GPS receiver.



Features: The three different feature types that can be collected with the GPS unit. In order from top to bottom; point, line (arc), and polygon.



Pause: When collecting positions for a feature you may pause the collection process.



Satellites: Number of satellites the GPS is able to connect to and receiver position data.



WAAS: Where the WAAS satellite is located in the skyplot. In newer versions of TerraSync may be called SBAS. WAAS is a real-time correction satellite.

GPS Problem Log

Date:

GPS unit:

User:

Park:

Problem/Error message:

Steps taken before problem occurred:

This page intentionally left blank.

Western Prairie Fringed Orchid Monitoring Protocol
Heartland I&M Network and Prairie Cluster Prototype Monitoring Program

Standard Operation Procedure 4: Western Prairie Fringed Orchid Census

Version 1.00 (07/01/2007)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

I. Procedures

1. Contact park resource manager in late June/early July to check on stage of western prairie fringed orchid flowering. In most years, peak flowering occurs in mid-July. The trip should be scheduled during peak flowering.
2. Maps and search area polygons on the Trimble GeoXT GPS unit outline the area in which the survey is conducted. Search areas occur in portions of prairie management units 2B and 3B (Figure 4.1). Search area in vicinity of orchid location in unit 4A.
3. Any corner of the search areas in units 2B and 3B and any appropriate corresponding cardinal direction may be selected to begin the search. The search pattern may be modified from year to year.
4. A crew of 3-7 individuals stands side-by-side, approximately 2-3 m apart, to form a line. The observers keep the line formation as they walk and search for orchids. While vegetative orchids may be incidentally found and recorded, the search focuses on flowering orchids. The pace of searching should be reasonably slow so that flowering individuals can be detected among the prairie vegetation.
5. The boundary on the leading edge of the search line is marked with wire flags. On the return pass, these wire flags are removed and the new leading edge is marked with wire flags.
6. Upon encountering an orchid, the handheld counter is advanced to track the orchid ID number.



Figure 4.1. Western prairie fringed orchid search areas in units 2B and 3B at Pipestone National Monument.

7. An observer records the orchid location with the GPS unit. A minimum of 25 points should be collected, although 50 points is preferred. The antenna for the GPS unit should be held directly over the plant while collecting position data.
8. Attribute data should be entered using the data dictionary (See SOP 4). A second observer typically makes these measurements.
9. After hearing the measurements, the GPS operator entering data should repeat the values to confirm that the right values were entered.
10. Measures to reduce trampling should be taken. These may include:
 - a. Picking feet up when walking across prairie.
 - b. Using two GPS units to minimize movement of GPS operator between orchids.
 - c. Avoiding mass gathering around orchids—often difficult given the orchid's beauty.
11. To collect capsule measurements, every 10th plant will be flagged with a small pink flag. A random number between 1 and 10 will be selected to determine the first plant to be marked. Plant ID number should be included on the flag.

The figure consists of two side-by-side screenshots of the TerraSync software interface.

The left screenshot shows the 'Choose Feature' dialog. At the top, it says 'File: R092610A' and 'Choose Feature:'. Below this is a table with two columns: 'Type' and 'Feature Name'. The 'Orchid' feature is selected. Below the table are three icons: a point, a line, and an area, each with a corresponding 'generic' label.

The right screenshot shows the data entry form for '1 Orchid'. It has a title bar 'TerraSync' and a menu bar 'Data'. Below the menu bar are buttons for 'Collect', 'Options', and 'Log'. The form contains the following fields:

- PlantID:** A text box with the value '0'.
- Phenology:** A dropdown menu with the value 'Reproductive'.
- HeightCm:** A text box with the value '77'.
- FlowerPositions:** A text box with the value '9'.
- HeightInfl:** A text box with the value '65'.
- Year_:** A dropdown menu with the value '2007'.
- Comments:** A large text area.

Figure 4.2. Data dictionary used to collect flowering orchid census data.

II. Data Dictionary and Measurement Details

1. The data dictionary was created using the data dictionary editor in Pathfinder software (Figure 4.2).
2. The only feature is designed to collect the location of an orchid: Orchid
3. The following attributes are added:
 - a. PlantID: Numeric attribute, min 0 to max 300. Assigned based on a continuous count of orchids. Count tracked using handheld counter (see SOP 1).
 - b. Phenology: Menu attribute, flowering or vegetative. Assigned based on flowering condition of plant. Focus of the study is flowering orchids, although vegetative plants are recorded when discovered.
 - c. HeightCm: Numeric attribute, min -1 to max 200. Assigned based on a height measurement (cm) from ground to top of plant. Top of plant is defined as the plant tissue that attains the greatest height relative to the ground.
 - d. Flower positions: Numeric attribute, min -1 to 40. Assigned based on a count of flowering buds and flowers. (Although broken pedicels may have been counted in the past, this practice is not continued in this protocol. The rationale is that broken pedicels are rarely encountered, may represent aborted flowers, and will not mature to produce capsules.)
 - e. HeightInfl: Numeric attribute, min -1 to max 200. Assigned based on height measurement (cm) from ground to base of inflorescence, indicated by the base of the bract of the lowermost flower. Measurement added in 2005.
 - f. Year_: Menu attribute. Assigned based on the year the census was completed.
 - g. Comments: Text attribute, length 50. This field records comments on plant condition or methodological issues.

Western Prairie Fringed Orchid Monitoring Protocol
Heartland I&M Network and Prairie Cluster Prototype Monitoring Program

Standard Operation Procedure 5: Vegetation Profile

Version 1.00 (07/01/2007)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

I. Procedure Overview

Measuring horizontal cover provides a description of vegetation structure, which is especially important in tallgrass prairies. Horizontal cover measurements are conducted at nine permanent points in the western prairie fringed orchid habitat.

II. Procedures

Data Form 5A should be used for recording data. Header information should be filled out before observations begin.

Vegetation profile is estimated at nine points within the site. A GPS unit is used to navigate to each point. At each point, the vegetation profile is estimated at three distances from the profile board: 1m, 5m, and 15m. As one person holds the profile board vertically, a second observer with a sighting pole moves 1, 5 and 15 meters in a south direction from the profile board, using a distance tape to accurately measure (Figure 5.1). The observer utilizes the sighting pole marked at 0.25, 0.5, 0.75, 1.0, 1.25 and 1.75 meters above the ground, corresponding to the center of each height interval, to adjust their eye position (Figure 10.2). Observers should sight with one eye to prevent parallax problems. The observer's eye should be the same distance above the ground as the center of the height interval being measured. The area of the cover board obscured by vegetation is measured in seven height intervals using modified Daubenmire cover classes (Table 5.1).



Height intervals:

0-0.5
0.25-0.75
0.5-1.0
0.75-1.25
1.0-1.5
1.25-1.75
1.5-2.0

Figure 5.1. Conducting the horizontal cover measurements using profile board and sighting pole.

Table 5.1. Modified-Daubenmire cover value scale used to estimate horizontal vegetation covers.

Cover Class Codes	Range of Cover (%)	Class Midpoints (%)
7	95-100	97.5
6	75-95	85.0
5	50-75	62.5
4	25-50	37.5
3	5-25	15.0
2	1-5	2.5
1	0-0.99	0.5

Appendix 5A.
Vegetation Profile Data Datasheet for Western Prairie Fringed Orchid Monitoring

Date: **Start Time:** **End Time:** **Collectors:**
Date Entered: **Date Verified:**

Point 1:

	1m	5m	15m
0 – 0.5 m			
0.25 – 0.75 m			
0.5 – 1.0 m			
1.0 – 1.5 m			
1.25 – 1.75 m			

Point 2:

	1m	5m	15m
0 – 0.5 m			
0.25 – 0.75 m			
0.5 – 1.0 m			
1.1 – 1.5 m			
1.25 – 1.75 m			

Point 3:

	1m	5m	15m
0 – 0.5 m			
0.25 – 0.75 m			
0.5 – 1.0 m			
1.2 – 1.5 m			
1.25 – 1.75 m			

Point 4:

	1m	5m	15m
0 – 0.5 m			
0.25 – 0.75 m			
0.5 – 1.0 m			
1.3 – 1.5 m			
1.25 – 1.75 m			

Point 5:

	1m	5m	15m
0 – 0.5 m			
0.25 – 0.75 m			
0.5 – 1.0 m			
1.4 – 1.5 m			
1.25 – 1.75 m			

Point 6:

	1m	5m	15m
0 – 0.5 m			
0.25 – 0.75 m			
0.5 – 1.0 m			
1.5 – 1.5 m			
1.25 – 1.75 m			

Point 7:

	1m	5m	15m
0 – 0.5 m			
0.25 – 0.75 m			
0.5 – 1.0 m			
1.6 – 1.5 m			
1.25 – 1.75 m			

Point 8:

	1m	5m	15m
0 – 0.5 m			
0.25 – 0.75 m			
0.5 – 1.0 m			
1.7 – 1.5 m			
1.25 – 1.75 m			

Point 9:

	1m	5m	15m
0 – 0.5 m			
0.25 – 0.75 m			
0.5 – 1.0 m			
1.8 – 1.5 m			
1.25 – 1.75 m			

**Western Prairie Fringed Orchid Monitoring Protocol
Heartland I&M Network and Prairie Cluster Prototype Monitoring Program**

Standard Operation Procedure 6: Soil Moisture

Protocol in development.

Western Prairie Fringed Orchid Monitoring Protocol
Heartland I&M Network and Prairie Cluster Prototype Monitoring Program

Standard Operation Procedure 7:
Western Prairie Fringed Orchid Capsule Monitoring

Version 1.00 (07/01/2007)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

I. Procedures

1. During the census of flowering western prairie fringed orchids (SOP 4), every 10th plant sampled, using a random start, is marked for capsule monitoring. This yields a systematic sample, adopted to minimize trampling. Selection of a random sample would require complete delineation of the flowering orchid population followed by a revisit to mark randomly selected flowering orchids.
2. At each plant, the following measurements are made (Appendix 7A: Capsule Monitoring Data Sheet):
 - a. Capsule number: Tally of capsules on plant using the following categories: aborted, partially developed, fully developed.
 - b. Plant height (top): Assigned based on a height measurement (cm) from ground to top of plant. Top of plant is defined as the plant tissue that attains the greatest height relative to the ground.
 - c. Plant height (base of inflorescence): Assigned based on a height measurement (cm) from ground to top of the base of the bract of the lowermost flower.
 - d. Notes on plant condition: Description of plant condition. May include observations on herbivory, dessication, etc. Following several years of field observations, the classification system will become more systematic.
 - e. Height to first capsule: Assigned based on a height measurement in cm from ground to location of the lowermost capsule pedicel on plant stem.

- f. Dimensions of each capsule: Measurement of capsule length and width in mm at the longest and widest points, respectively, with Vernier calipers (SOP 1).
- g. Notes on capsule condition: Description of capsule condition. May include observations on herbivory, insect damage, fungal damage, abortion, malformation, etc. Following several years of field observations, the classification system will become more systematic.

Appendix 7A: Capsule Monitoring Data Sheet

Plant #	Capsule #	Plant Height (cm)	Height to 1 st Capsule (cm)	Plant Condition	
	Capsule #	Capsule Condition (aborted, partially developed, fully developed)		Width (cm)	Length (cm)
	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				

**Western Prairie Fringed Orchid Monitoring Protocol
Heartland I&M Network and Prairie Cluster Prototype Monitoring Program**

Standard Operation Procedure 8: Precipitation Data

Version 1.00 (07/01/2007)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

I. Procedures

1. Precipitation data (rain, snow, ice, etc.) are obtained from Nation Weather Service Monitoring Station 216565 in Pipestone, Minnesota through a cooperative agreement with the University of Missouri – Columbia.
2. Codes for trace precipitation (“T”) and missing data (“M”) are replaced with the 0.001 and a null record, respectively.
3. Data are received as a .txt file and imported into an MS Access database by appending data to the current table.
4. The main data table tbl_PIPE_Weather consists of five fields:
 - a. ID –autonumber unique identifier
 - b. Year – year of data collection
 - c. Month – month of data collection
 - d. Day – day of month of data collection
 - e. Precip_in – precipitation (includes frozen precipitation) in inches
5. A series of queries have been generated to summarize the precipitation data into the following precipitation categories based on Wolken (1995) and Willson (in prep.):

Precipitation Category	Dates
Previous growing season (PGS-)	Calculated as sum precipitation for March - September of previous year
Mature Growth (MG-)	Calculated as sum precipitation for June and July of previous year
Bud development (BD-)	Calculated as sum precipitation for August of previous year
Post-senescence (PS-)	Calculated as sum precipitation for September of previous year
Dormant season (DS-+)	October - November of previous year and January - March of current year
Current growing season (CGS+)	Calculated as sum precipitation for March - September of current year
Emergence (EM+)	Calculated as sum precipitation for April and May of current year
Mature Growth (MG+)	Calculated as sum precipitation for June 16 – July 15 of current year

6. The queries for each precipitation category can be categorized as three types:
 - a. Type 1 – Selects data for the appropriate months for all years based on the precipitation category.
 - b. Type 2 – Summarizes precipitation category data by year.
 - c. Type 3 – Offsets data by one year to look at lag effects from precipitation during previous year.
7. These categories may be modified following review of plant phonological monitoring data.

II. Literature Cited

Willson, G.D., M.J. Page, and F.A. Akyuz. 2006. Precipitation and fire effects on flowering of a rare prairie orchid. *Great Plains Research* 16:37-43.

Wolken, P.M. 1995. Habitat and life history of the western prairie fringed orchid (*Plantanthera praeclara*). M.S. thesis. University of Wyoming, Laramie, Wyoming.

**Western Prairie Fringed Orchid Monitoring Protocol
Heartland I&M Network and Prairie Cluster Prototype Monitoring Program**

Standard Operation Procedure 9: Data Management

Version 1.00 (07/01/2007)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

I. Data Management Files

1. Western prairie fringed orchid rover file – The file contains census information collected using the GPS data dictionary in the field. The file is corrected using base station files.
2. Western prairie fringed orchid shapefile – The corrected rover file is exported as a shapefile using Pathfinder Office and appended to an existing shapefile that contains orchid locations for all years.
3. Western prairie fringed orchid database (WPFO_1.0.mdb) – The database contains three tables: one table with many of the fields from the shapefile (plant height, height to base of inflorescence, number of flower positions), one table with plant measurements made during capsule monitoring, and one table with plant measurements made during capsule monitoring.
4. Precipitation database (PIPE_Habitat.mdb) – The precipitation database includes daily precipitation data from National Weather Service station 216565, soil moisture data from the local monitoring station, and vegetation profile data.

II. Metadata

Metadata for the western prairie fringed orchid data management files are developed using NPS Dataset Catalog Version 2 (for Access 2003) and USGS metadata parser tool, 'mp'. Metadata for western prairie fringed monitoring data will be available at NPS I&M application server: <http://science.nature.nps.gov/im/apps.htm>.

III. Data Structure, Data Updates, and Data Entry

The core western prairie fringed orchid biological data are stored in the table tbl_Orchids, tbl_Capsules, and tbl_Orchids_Capsules. Exports for analysis are typically made from this database. The table tbl_Orchid is updated annually by importing the .dbf file associated with the shapefile. Information collected during capsule monitoring is entered directly in tbl_Capsules and tbl_Orchids_Capsules.

The core western prairie fringed orchid precipitation data are stored in the table tbl_Precip. The tables are updated annually by importing the text file of the most recent precipitation data in to the database and then appending the data to tbl_Precip. Soil moisture data from the local monitoring station are stored in tbl_SoilMoisture, while vegetation profile data are stored in tbl_VegProfile.

IV. Data Verification

Data verification requires a check of the accuracy of computerized records against the original data source, usually paper field records to minimize transcription errors. Staff who understand data collection procedures verify all records to their original source. For western prairie fringed orchid monitoring, census data are collected using the GPS receiver so verification is not required. Capsule and horizontal cover monitoring use paper records, so verification to this source is required. Additionally, ten percent of the records are reviewed a second time by the project manager. The results of that comparison are reported with the data. If errors are found during this second review, the entire data set is verified again. Once the electronic data are verified as accurately reflecting the original field data, paper data sheets are archived. The electronic version is used for all subsequent data activities.

V. Data Validation

Correctly transcribed data may still contain errors in accuracy. Validation procedures seek to identify generic errors (e.g., missing, mismatched or duplicate records) and errors specific to particular projects. For example, a height for an orchid may be entered that is not biologically reasonable. During the census, the data dictionary controls a number of data entry measurements (see SOP 4). In the database WPFO_1.0.mdb, the tables tbl_Orchids and tbl_Orchid_Capsules use Period_ID and Orchid_ID jointly as the primary key. Duplicates are allowed in each field individually. The database PIPE_weather.mdb uses the field ID as the primary unduplicated key. Any changes made to the data during the data validation phase, should be made with marginal notes on the original field forms rather than by erasure.

Spatial data are validated using ESRI ArcGIS 9.x (ESRI, Inc.). Orchid locations are compared against park management unit boundaries and DRG or DOQQ layers.

VI. Database Administration

Data Maintenance

Data sets often change through additions, corrections, and improvements made following data verification. Three rules should be observed in this process:

1. Only make changes that improve or update the data while maintaining data integrity.
2. Once archived, document any changes made to the data set.
3. Be prepared to recover from mistakes made during editing.

Any editing of archived data is accomplished jointly by the project manager and data manager. Every change must be documented in the edit log and accompanied by an explanation that includes pre- and post-edit data descriptions. Original field forms are not altered. Field forms can be reconciled to the database through the use of the edit log.

Data Organization

The network monitoring program requires management of a large number of files and folders (e.g., reports, GIS layers). Network experiences attest to the importance of file management. For example, databases are occasionally stored in two versions of MS Access in order to accommodate data users with different software versions. GIS data are sometimes stored in two different file types – one for navigation, the other for use with existing base GIS data. Poor file organization can lead to confusion and data corruption. To the extent possible, files should only be kept in one location.

Version Control

Prior to making major changes to a data set, a back-up copy is stored with a unique version number. With proper controls and communication, versioning ensures that only the most current version is used in any analysis. Versioning of archived data sets is handled by adding a floating-point number to the file name with the first version being numbered 1.00. Each major version is assigned a sequentially higher whole number. Each minor version is assigned a sequentially higher .01 number. Major version changes include migrations across Access versions and complete rebuilds of front-ends and analysis tools. Minor version changes include fixes in front-end and analysis tools. Frequent users of the data are notified of the updates and provided with a copy of the most recent archived version.

Data Backups

Data archive is the most important part of data management activity. Servers go down and don't come back. The data manager needs to be able to restore data to alternate servers or workstations. In this sense, a reliable tape backup device is more critical than the server itself. For the deer database and other monitoring databases, we run complete backups (no incremental backups) each Monday, Wednesday and Friday. Monday tapes are held for a month. Archive tapes are made quarterly and stored for 18 months. Back-up logs are reviewed on every job and file restores are run once per month just to be sure the system is working.

VII. Data Availability

The western prairie fringed orchid is a federally threatened plant. Monitoring data associated with this species is not currently available to the public per NPS Director's Order 66. For further information contact:

Data Manager
Wilson's Creek National Battlefield
6424 W. Farm Road 182
Republic, MO 65738-9514
gareth_rowell@nps.gov

**Western Prairie Fringed Orchid Monitoring Protocol
Heartland I&M Network and Prairie Cluster Prototype Monitoring Program**

Standard Operation Procedure 10: Data Summary and Analysis

Version 1.00 (07/01/2007)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

I. Distribution Map

Maps of orchid distribution are created in ArcGIS (Figure 9.1). The maps are yearly side by side comparisons. All maps should use the same scale and display the park roads.

II. Data Summary

The flowering orchid census data, capsule data, and precipitation data are summarized in the following manner using queries in Access databases:

1. Number of flowering (reproductive) orchids.
2. Mean plant height.
3. Mean flower number per plant.
4. Mean capsule number per capsule-producing plant.
5. Mean ratio of capsules to flowers.
6. Mean capsule width and length.
7. Annual precipitation data and soil moisture data are grouped to correspond with orchid life-history stages (see SOP 6 and 8).
8. Mean vegetation cover for vegetation profile strata.

The following calculations are made based on records in the database:

1. Percentage of plants producing capsules.
2. Percentage of plants in various conditions.
3. Percentage of capsules in various conditions.

A plant and capsule condition classification is being developed based on field observations, but is not complete at this time.

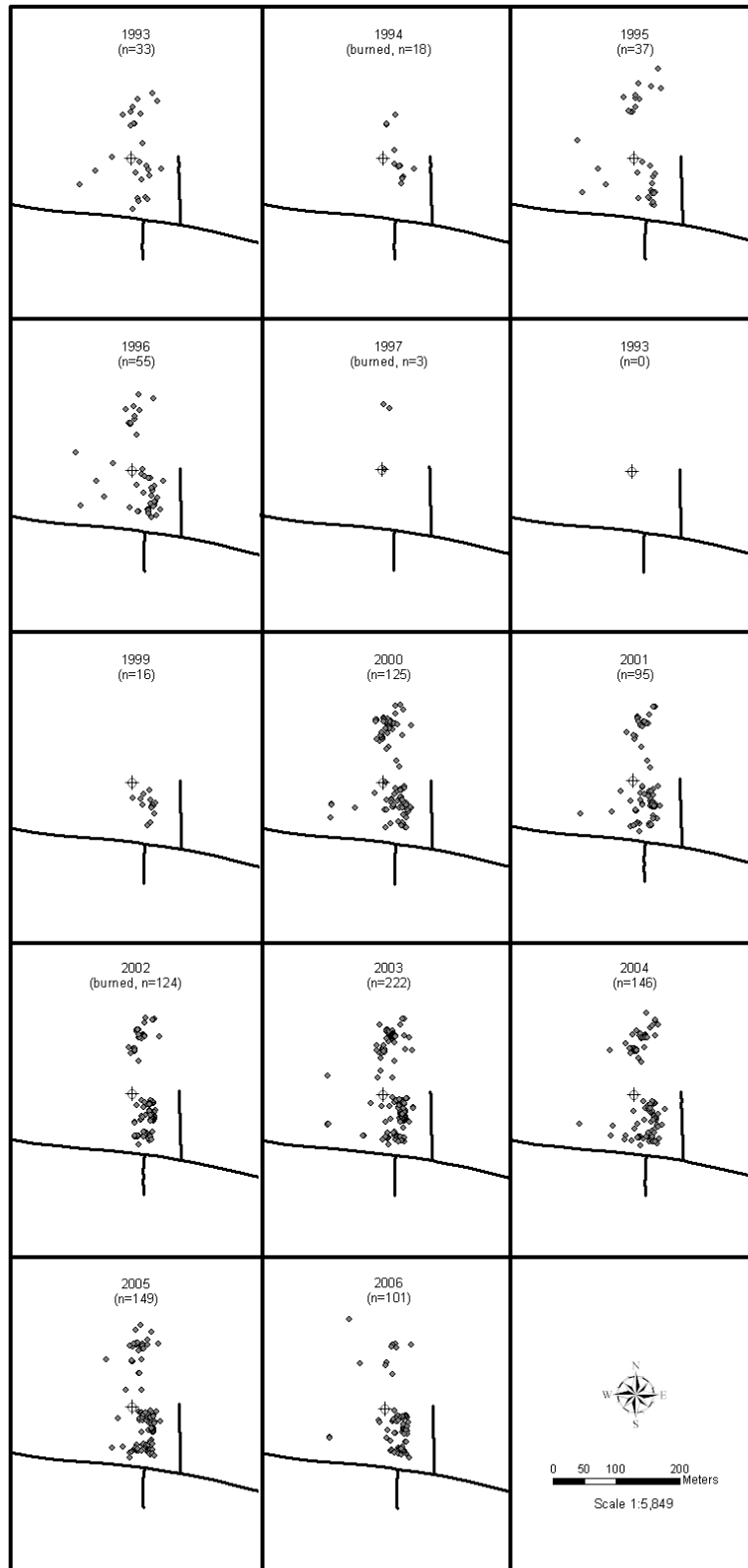


Figure 11.1 Western prairie fringed orchid distribution at Pipestone National Monument, 1993-2006.

III. Data Analysis

Because the entire population of flowering plants is censused, differences in flowering orchid count numbers, plant height, and flower number per plant among years are true differences. Inferential statistics are not required. The standard deviation of plant height, flowers per plant, and mean vegetation cover per horizontal stratum is reported to provide a measure of natural variability about the mean. The mean of plant and capsule measurements collected during capsule monitoring will also be reported with 95% confidence intervals. Regression or comparable analyses will be employed to evaluate the population size-habitat relationships.

This page intentionally left blank.

**Western Prairie Fringed Orchid Monitoring Protocol
Heartland I&M Network and Prairie Cluster Prototype Monitoring Program**

Standard Operation Procedure 11: Reporting

Version 1.00 (07/01/2007)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

I. Report Format

Template

The report template for regional natural resource technical reports should be followed (<http://www.nature.nps.gov/publications/NRPM/index.cfm>). Natural resource reports are the designated medium for disseminating high priority, current natural resource management information with managerial application. The natural resource technical reports series is used to disseminate the peer-reviewed results of scientific studies in the physical, biological, and social sciences for both the advancement of science and the achievement of the National Park Service's mission.

Style

Standards for scientific writing as recommended in the CBE Style Manual (1994) should be followed. Reports should be direct and concise. Refer to CBE Style Manual (CBE Style Manual Committee 1994) or Writing with Precision, Clarity and Economy (Mack 1986), Strunk and White (2000), Day (1983), and Batzli (1986).

II. Types of Reports and Review Process

Table 10.1 summarizes the types of reports produced and review process. Adapted from Debacker *et al.* 2005.

Type of Report	Purpose of Report	Primary Audience	Review Process	Frequency
Annual Status Reports for Specific Protocols	Summarize monitoring data collected during the year and provide an update on the status of selected natural resources. Document related data management activities and data summaries.	Park resource managers and external scientists	Internal peer review by HTLN staff	Annually
Executive Summary of Annual Reports for Specific Protocols	Same as Annual Status Reports but summarized to highlight key points for non-technical audiences.	Superintendents, interpreters, and the general public	Internal peer review by HTLN staff	Simultaneous with Annual Status Reports
Comprehensive Trends and Analysis and Synthesis Reports	Describe and interpret trends in individual vital signs. Describe and interpret relationships among observed trends and park management, known stressors, climate, <i>etc.</i> Highlight resources of concern that may require management action.	Park resource managers and external scientists	Internal peer review by HTLN staff	Every 5-7 years
Executive Summary of Comprehensive Trends and Analysis and Synthesis Reports	Same as Comprehensive Trends and Analysis and Synthesis Reports, but summarized to highlight findings and recommendations for non-technical audiences.	Superintendents, interpreters, and the general public	Internal peer review by HTLN staff	Simultaneous with Comprehensive Trends Analysis and Synthesis Reports

III. Report Distribution

Following review, annual reports will be distributed by September 1 of the year following data collection. Reports can also be distributed to partners involved in conservation of the monitored resource. This determination is made by the park, the network, and/or the regional office. All data collected is public property and subject to requests under the Freedom of Information Act (FOIA). However, sensitive data, such as the location of rare species, must be withheld in some cases. Reports containing non-sensitive data will be made publicly available and disseminated through the network website and the biodiversity data store (<http://www.nature.nps.gov/biology/biologicalinventories/biodiversitydatastore.cfm>).

IV. Literature Cited

Batzli, G.O. 1986. Thoughts while cleaning out old editorial files. *Bulletin of Ecological Society of America* 67:167-168.

CBE Style Manual Committee. 1994. *Scientific style and format: the CBE manual for authors, editors, and publishers*. Sixth edition. Council of Biology Editors, Cambridge University Press, New York, New York, USA.

Day, R.A. 1983. *How to write and publish a scientific paper*. Second edition. ISI Press, Philadelphia, Pennsylvania, USA.

DeBacker, M. D., C. C. Young (editor), P. Adams., L. Morrison, D. Peitz, G. A. Rowell, M. Williams, and D. Bowles. 2005. *Heartland Inventory and Monitoring and Prairie Cluster Prototype Monitoring Program vital signs monitoring plan*. U.S. National Park Service, Heartland I&M Network and Prairie Cluster Prototype Monitoring Program, Wilson's Creek National Battlefield, Republic, Missouri.

Mack, R.N. 1986. Writing with precision, clarity, and economy. *Bulletin of Ecological Society of America* 67:31-35.

Strunk, W. Jr., and E.B. White. 2000. *The Elements of Style*. Fourth Edition. Macmillan, New York, New York, USA.

**Western Prairie Fringed Orchid Monitoring Protocol
Heartland I&M Network and Prairie Cluster Prototype Monitoring Program**

Standard Operation Procedure 12: Revising the Protocol

Version 1.00 (07/01/2007)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

I. Procedures

1. In the event that the western prairie fringed orchid monitoring protocol requires editing, all edits must be reviewed for technical merit. Minor changes to the protocol will only require in-house review by network staff. Major changes in the protocol require external review by subject matter experts.
2. Protocol edits and versioning are tracked in the revision history log attached to each narrative and SOP. Major changes result in an update by whole numbers (i.e. version 1.0, version 2.0, etc.) and minor changes by hundredths (e.g., version 1.01, version 1.02, etc). Record the previous version number, date of revision, author of the revision, describe the change, provide a rationale for the change, and assign a new version number.
3. Inform the data manager about changes to the protocol narrative or SOPs, so the new version number can be incorporated in the project database metadata. The data manager may need to edit the database if the changes affect database structure.
4. Post new protocol versions on the network website and forward copies to all individuals with a previous version of the affected protocol narrative or SOP.

The NPS has organized its parks with significant natural resources into 32 networks linked by geography and shared natural resource characteristics. HTLN is composed of 15 National Park Service (NPS) units in eight Midwestern states. These parks contain a wide variety of natural and cultural resources including sites focused on commemorating civil war battlefields, Native American heritage, westward expansion, and our U.S. Presidents. The Network is charged with creating inventories of its species and natural features as well as monitoring trends and issues in order to make sound management decisions. Critical inventories help park managers understand the natural resources in their care while monitoring programs help them understand meaningful change in natural systems and to respond accordingly. The Heartland Network helps to link natural and cultural resources by protecting the habitat of our history.

The I&M program bridges the gap between science and management with a third of its efforts aimed at making information accessible. Each network of parks, such as Heartland, has its own multi-disciplinary team of scientists, support personnel, and seasonal field technicians whose system of online databases and reports make information and research results available to all. Greater efficiency is achieved through shared staff and funding as these core groups of professionals augment work done by individual park staff. Through this type of integration and partnership, network parks are able to accomplish more than a single park could on its own.

The mission of the Heartland Network is to collaboratively develop and conduct scientifically credible inventories and long-term monitoring of park “vital signs” and to distribute this information for use by park staff, partners, and the public, thus enhancing understanding which leads to sound decision making in the preservation of natural resources and cultural history held in trust by the National Park Service.

www.nature.nps.gov/im/units/htln/



The Department of the Interior protects and manages the nation’s natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

**National Park Service
U.S. Department of the Interior**



Natural Resource Program Center

Natural Resource Program Center
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov

EXPERIENCE YOUR AMERICA™